2014-1241

United States Court of Appeals for the Federal Circuit

SPLIT PIVOT, INC.,

Plaintiff-Appellant,

v.

TREK BICYCLE CORPORATION,

Defendant-Appellee.

Appeal from the United States District Court for the Western District of Wisconsin Case No. 3:12-CV-00639, Judge William M. Conley

NON-CONFIDENTIAL BRIEF FOR PLAINTIFF-APPELLANT SPLIT PIVOT, INC.

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CERTIFICATE OF INTEREST

Counsel for Appellant Split Pivot, Inc. hereby certifies the following:

1. The full name of every party represented by me is:

   Split Pivot, Inc.

2. The name of the real party in interest represented by me is:

   Split Pivot, Inc.

3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party represented by me are:

   None.

4. The names of all law firms and the partners or associates that appears for any of the parties represented by me in the trial court or are expected to appear in this Court are:

   Alan Anderson Law Firm LLC: Alan M. Anderson, Aaron C. Nyquist

   Kutak Rock LLP: Christopher A. Young

   Briggs and Morgan P.A.: Christopher A. Young

   Dewitt Ross & Stevens S.C.: Joseph J. Ranney, Joseph T. Leone

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CONFIDENTIAL MATERIAL OMITTED

The material omitted on page 7 relates to the circumstances surrounding Trek's reaction to Weagle's design; the material omitted on page 8 relates to Trek's reaction to Weagle's design; the material omitted on page 65 relates to Trek's internal policies regarding intellectual property; the material omitted on page 66 relates to Trek's reaction to Weagle's design.

TABLE OF AUTHORITIES

Cases

Statutes

STATEMENT OF RELATED CASES

No appeal in or from the same civil action or proceeding in the lower court was previously before this or any other appellate court. No case is known to counsel to be pending in this or any other court that will directly or indirectly be affected by this Court's decision in the pending appeal.

JURISDICTIONAL STATEMENT

This is an appeal from an order construing certain limitations of the claims in issue and granting summary judgment of non-infringement and no willful infringement based upon those claim constructions. The District Court had jurisdiction pursuant to 28 U.S.C. §1332(a)(1).

The District Court's final judgment was entered on December 17, 2013. Appellant Split Pivot, Inc. ("Split Pivot") timely filed a notice of appeal on January 9, 2014. This Court has jurisdiction pursuant to 28 U.S.C. §1295(a)(1).

STATEMENT OF THE ISSUES

1. Did the District Court err when it construed certain limitations in U.S. Patent No. 7,717,212 ("the '212 Patent") contrary to the figures and specification, which thereby excluded the preferred and disclosed embodiments and an express limitation, and then granted summary judgment of non-infringement?

2. Did the District Court err when it construed certain limitations in U.S. Patent No. 8,022,301 ("the '301 Patent") contrary to the specification and file history, admittedly excluding a disclosed embodiment, and then granted summary judgment of non-infringement?

3. Did the District Court err when it granted summary judgment of no willful infringement, despite evidence that Trek knowingly disregarded an objective risk of infringement when it began selling bicycles equipped with Active Braking Pivot technology?

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STATEMENT OF THE CASE

Split Pivot commenced this action against Appellee Trek Bicycle Corporation ("Trek") for willfully infringing the '212 Patent and the '301 Patent (collectively, "the Patents"). Prior to the court issuing any claim construction ruling, the parties filed cross-motions for summary judgment. Split Pivot moved for summary judgment that Trek infringed claim 22 of the '212 Patent. Trek moved for summary judgment of non-infringement, invalidity, and no willful infringement.

Based on erroneous claim constructions, the District Court granted Trek's motion for non-infringement. The District Court's claim constructions violated fundamental principles and excluded every preferred and disclosed embodiment of the Patents from the scope of the claims.

In light of its finding of non-infringement, the District Court granted Trek's motion for summary judgment of no willful infringement. This Court should reverse the District Court's judgment and remand for further proceedings.

STATEMENT OF FACTS

A. The Parties.

Split Pivot is a small, privately-held corporation and the owner by assignment of the Patents, which relate to rear suspension systems for full suspension mountain bikes, among other vehicles. Trek is a Wisconsin corporation and one of the largest bicycle retailers in the United States.

B. Rear Suspension Technology.

While a traditional bicycle consists of a solid frame of integrated tubes, a bicycle with a rear suspension system consists of a rigid front triangle and a rear wheel connected to the front triangle by a series of links. A2. These links are generally connected to a shock absorber. *Id*. The benefit of a bicycle with a rear suspension system is that the rear wheel may move up and down as it encounters rough terrain, which increases rider comfort and control. *Id*.

The distance a rear wheel may move up and down within the limits of the shock absorber is known as the compressible wheel suspension travel distance. A3. The beginning travel point is where the suspension is completely uncompressed, and the end travel point is where the suspension is completely compressed. *Id*. By measuring the travel distances of both the wheel and the shock absorber, a "leverage ratio" can be calculated. *Id*. The leverage ratio is the ratio of the compressive wheel travel change divided by the measured length

change in the shock absorber over an identical and correlating wheel travel distance. A116. The leverage ratio can be graphed on a leverage rate curve, which is a graphical representation of leverage ratio versus wheel travel. A129-130. A leverage rate curve (or leverage ratio curve) is plotted on a Cartesian graph where the leverage ratio is shown on the Y-axis, and the vertical wheel travel is shown on the X-axis. *Id*.

Because shock absorber length may be changed by the movement of the wheel, brake, and/or control links as part of the rear suspension, leverage ratios may be manipulated to achieve a given force output at the wheel. A4-5. While every rear suspension inherently has a leverage ratio and an accompanying leverage ratio curve, different suspension systems may be designed to have a particular leverage ratio curve. *Id*. However, the interaction between acceleration forces from the pedal driven drivetrain and braking forces from the braking system can have secondary, negative effects on the performance of the rear suspension. A5.

C. Split Pivot Revolutionizes the Industry.

David Weagle is the president and CEO of Split Pivot. In early 2005, he considered ways to improve the performance of full suspension mountain bikes and invented a suspension system that would separate braking and suspension forces in a cost-effective way, thereby improving handling while braking and

accelerating. A307-310; A3801-3805. Weagle conceived of his invention at least as early as June 15, 2005. *Id.* Patent Application No. 11/510,522 was filed on August 23, 2006, and issued as the ‘212 Patent. *Id.* at 10. Weagle filed Patent Application No. 11/895,269 as a continuation in part of the ‘212 Patent on August 23, 2007, which issued as the ‘301 Patent. The inventions claimed in the Patents are known throughout the industry as “Split Pivot.”

The ‘212 Patent “relates to suspension systems comprising, in certain embodiments, a pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by placement of an instant force center, and so that acceleration forces can be controlled by a swinging wheel link.” A73. Split Pivot has been acclaimed throughout the bicycle industry as an innovative and revolutionary suspension system that effectively separates braking and acceleration forces in full suspension bicycles in a cost effective way, allowing the rider to maintain superior control over the bike on rocky terrain. A2429-2442.

D. Trek Contacts Dave Weagle.

In early 2012, Dylan Howes, a Trek employee, contacted Weagle and inquired about a different suspension design and whether Weagle had any new designs. Weagle responded that he had a new design for which he had applied for a patent, and subsequently had further conversations with Howes, another Trek

engineer, Jose Gonzalez, and Joe Vadeboncoeur, the Director of Product Development at Trek.

After negotiating a mutual confidentiality agreement, Weagle sent an email to Vadeboncoeur, attaching a copy of a presentation regarding his then patent-pending new design. A4109-4119. This presentation included several illustrations of Split Pivot prototype drawings, including one that became Figure 3 in the '212 Patent; explained Split Pivot from a designer's perspective; explained leverage rate curves; and discussed the separation of anti-squat, brake squat, and leverage rates. *Id*. Anti-squat and brake squat refer to the ability of the rear suspension to stay active and not compress while under the weight of the rider. A168-169.

Approximately three weeks after Trek received the presentation, Vadeboncoeur informed Weagle that Trek had [redacted] A4129. Vadeboncoeur also stated that Trek was [redacted] *Id*. When asked whether the images in the presentation looked similar to Trek's design, Howes testified, [redacted] A6762-6763. Nevertheless, Trek still wanted to meet with Weagle to discuss the Split Pivot technology. *Id*. Trek emailed a list of discussion topics,

including the Split Pivot invention, its history, any patent applications, and the conception date. A4136.

Weagle attended a meeting at Trek on April 26, 2007, with Vadeboncoeur, Howes, and Gonzalez. *Id.* During that meeting, Weagle walked the Trek representatives through the presentation and answered questions regarding Split Pivot's performance advantages. A473-481. Trek's representatives also asked Weagle questions regarding the application and conception dates for the application that later issued as the '212 Patent, which he declined to answer. A505. Weagle expressed his willingness to work with Trek. A500-501.

Following the meeting, Weagle and Trek engaged in a series of discussions relating to the potential sale of the then-pending application that eventually became the '212 Patent. During the discussions, Trek repeatedly asked Weagle for the patent application number, which he declined to provide. A505-511. Trek and Split Pivot were unable to reach any agreement on the sale of the Split Pivot technology. A517-520. Gonzalez then told Weagle that Trek was going to [redacted] A518.

E. Trek Introduces Its Infringing ABP Equipped Bicycles.

Trek did not file a patent application on its alleged invention until after it had received and reviewed the presentation materials from Weagle. A3830;

A4231-4247. Trek's application was rejected as being anticipated by Weagle's then-pending application for the '212 Patent – rejections Trek overcame only by attempting to swear behind the filing date of Weagle's then-pending application. A1986-1993; A3832-3833.

Trek unveiled its 2008 model year mountain bikes in May and June of 2007. Trek's design was virtually identical in appearance to the invention claimed in the Patents and as disclosed by Weagle at the April 2007 meeting. Trek's line of bicycles featured a suspension system that it referred to as Active Braking Pivot ("ABP"), which featured a wheel link floating pivot concentric with the rear wheel rotation axis. Like Split Pivot, the purpose of ABP is to ensure that the rear suspension remains active while under acceleration or braking forces.

Almost immediately upon the introduction of ABP, Weagle began receiving inquiries from others in the bicycle industry expressing confusion between ABP and Split Pivot. A2443-2448; A3973-3976; A3984. Even Trek acknowledged the similarities and could not identify meaningful distinctions between ABP and Split Pivot. A2448-2452.

F. Trek's Infringing Bicycles.

Trek's infringing bicycles fall into two categories: (1) those equipped solely with ABP; and (2) those equipped with ABP and what Trek refers to as "Full

Floater." A10. An example of an ABP bike, the 2010 Superfly 100, is shown below:

A2781. In ABP bicycles, the shock absorber is oriented generally horizontally and fixed on one end to the "control link" (referred to above as a "swing link"), while the other end is affixed to the front triangle of the bicycle. The motion of the brake link is controlled by "control link" that is affixed to the front triangle. Aside from the Superfly 100, other ABP infringing bicycle models include the Trek Hifi, Rumblefish, and Roscoe. A2780.

Full Floater bicycles differ in that in addition to ABP, they also have a floating shock absorber that is not affixed to the front triangle of the bicycle. An example of a Full Floater bicycle, the 2010 Fuel EX 9.9, is shown below:

A2780. In Full Floater bicycles, the shock absorber is oriented vertically and is connected at the top end to a “control link” (referred to as a “rocker link”) and at the bottom end to the wheel link. Because both of these links are moveable, the shock absorber “floats” between the links instead of being solidly affixed to the front triangle. Trek Full Floater models include the Fuel EX, Scratch, Scratch Air, Top Fuel, Session, Slash, Lush, and Remedy. A2779. (All infringing Trek bicycles are collectively referred to as the “Accused Bicycles.”)

G. Split Pivot’s Claims.

Split Pivot commenced this action in August 2012. Split Pivot alleged that Trek’s Accused Bicycles infringed claims 1, 3, 4, 5, 6, 12, 14, 21, 22, 24, 25, 26, 32, 34, 41, 42, 43, 44 and 64 of the ‘212 Patent and claims 29, 30, 31, 37, 38, 39,

and 43 of the '301 Patent. Claims 1, 22, and 43 are independent claims. Claim 1 of the '212 Patent states:

> A suspension system for a vehicle comprising
>
> a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link and a shock absorber,
>
> wherein said wheel link floating pivot is concentric with said wheel rotation axis;
>
> wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link;
>
> wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid;
>
> and wherein force that compresses said shock absorber is transmitted through said brake link;
>
> and wherein said brake link passes on two sides of a frame member.

A91. Claim 22 is broader than claim 1 in that it lacks the "wherein said brake link passes on two sides of a frame member" limitation. *See* A92.

With regard to the '301 Patent, claims 29 and 37 are independent claims. Claim 29 of the '301 Patent states:

> A suspension system for a vehicle comprising
>
> a wheel link floating pivot,
>
> a wheel rotation axis,
>
> a wheel link,
>
> a control link,

a brake link,

a control link floating pivot,

a control link fixed pivot,

and a shock absorber;

wherein the distance between said wheel link floating pivot and control link floating pivot is greater than the distance between said control link fixed pivot and control link floating pivot;

wherein said wheel link is pivotally connected to said brake link;

wherein said brake link is pivotally connected to said control link;

wherein said wheel link floating pivot is concentric with said wheel rotation axis;

wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid;

wherein force is transmitted to said shock absorber through an element selected from the group consisting of the brake link, the control link, a wheel link fixed pivot, the control link floating pivot and the control link fixed pivot;

wherein said suspension system further comprises a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place;

and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning 1/3 (third) and in the end 1/3 (third), and a change in slope value in the middle 1/3 (third).

A131-132.

H. The District Court's Order.

Split Pivot moved for summary judgment on claim 22 of the '212 Patents. A2508; A2514-2515. Trek moved for summary judgment of non-infringement on all asserted claims, and for invalidity based on inadequate written descriptions of various claims of the '212 Patent and based on anticipation on all asserted claims of the '301 Patent. A2760-2762.

On December 13, 2013, the District Court construed various limitations in issue. Based on three of those claim constructions, the court granted Trek's motion for summary judgment of non-infringement and no willful infringement. A59-71.

While claims are to be construed from the perspective of one of ordinary skill in the art, the District Court failed to define such a person. A14-16. As a result, the District Court's claim construction was untethered from the art of "bicycle suspension design." A1932-1935.

With regard to the '212 Patent, the District Court's decision turned on its construction of two limitations. These limitations included alleged Markush groups: "wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid" (the "Shock Absorber Markush term"); and "wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link" (the "Mounting Markush term") (collectively, the "Markush Group Claim Terms").

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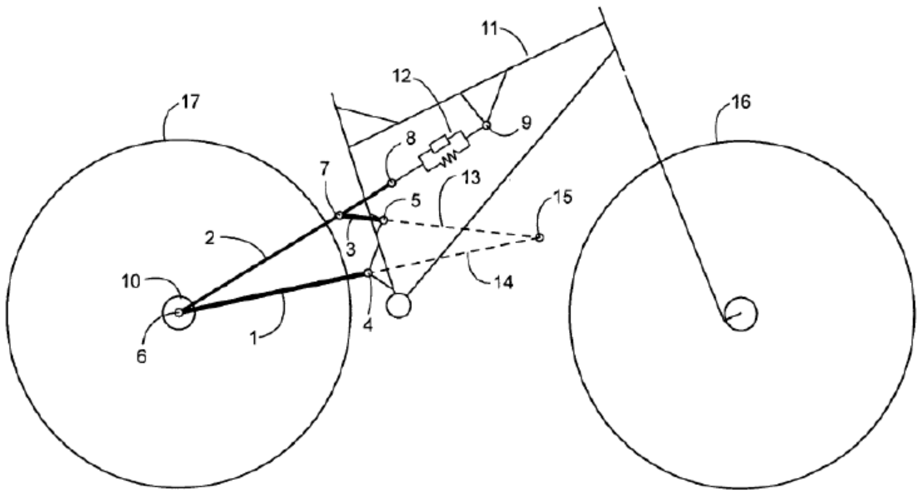
Although its grant of summary judgment was not based on its construction of the "brake link passes on two sides of a frame member," the District Court's construction of this limitation also was in error.

The District Court construed the Shock Absorber Markush term to mean "wherein said shock absorber consists of one, and only one, of the following: a compression gas spring, a leaf spring, a coil spring, and a fluid." A40-43. The District Court noted that the parties did not dispute that shock absorbers including both a spring and a fluid damper were "well known in the art" at the time the application for the '212 Patent was filed. A42. But the District Court ignored this fact and instead followed a form of analysis contrary to this Court's precedents in *Abbott Laboratories v. Baxter Pharmaceutical Products, Inc.*, 334 F.3d 1274, 1280 (Fed. Cir. 2003) and *Norian Corp. v. Stryker Corp.*, 432 F.3d 1356 (Fed. Cir. 2005).

Moreover, the District Court's construction of the Shock Absorber Markush term excluded every preferred embodiment of the '212 Patent. In Figures 1 and 2 of the '212 Patent, "[t]he shock absorber is located at 12."



(Pictured: Figure 1 of the '212 patent, which features a bicycle design with a rear suspension system. The shock absorber is located at 12; the links are located at 1, 2 and 3.)

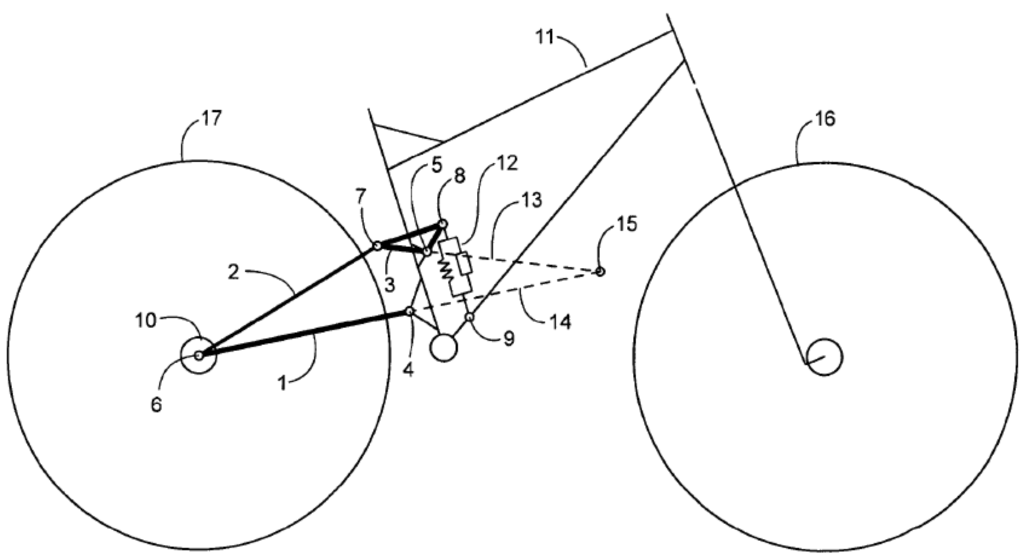


FIGURE 2

A3; A76. In Figures 1 and 2, the shock absorber (12) is drawn using the same symbol, which is the standard engineering symbol for a spring damper, which includes both a spring and a fluid. A7885-7917. As a result, by construing the

Shock Absorber Markush term to mean "one, and only one" of a compression gas spring, a leaf spring, a coil spring, and a fluid, the District Court excluded every embodiment disclosed in the '212 Patent.

The District Court construed the Mounting Markush term to mean "wherein said shock absorber is mounted to one, and only one, link selected from the group consisting of a brake link, a control link, and a wheel link." A33-40. However, the '212 Patent explicitly provides for embodiments where a shock absorber is mounted to more than one link. The '212 Patent states, "In certain embodiments, a shock absorber is mounted to a brake link and/or a control link in a pivotal manner." A82. The specification also states, "Throughout this application the singular includes the plural and the plural includes the singular, unless indicated otherwise." A91. But the District Court ignored this language in construing the Mounting Markush term.

As with the Shock Absorber Markush term, the District Court also ignored Trek's expert's admission that a person of ordinary skill would have known, reading the '212 Patent specification, that a shock absorber could be mounted to more than one of the links selected from the Markush group. A809. Split Pivot's expert similarly opined that shock absorbers suspended between two moveable links, known as a "floating configuration," date from at least 1980. A2116-2122. Weagle himself designed a bicycle with a floating shock configuration that was

sold in 2004, prior to the conception of the invention in the ‘212 Patent. A2015-2016.

Finally, although not relied upon by the District Court for its finding of non-infringement, it construed the “brake link passes on two sides of a frame member” limitation to mean the “brake link extends beyond both lateral sides of a structural support for components of a suspension system.” A23, A27. In doing so, the District Court erroneously construed “passes” and “frame members.” Again, the District Court’s construction is inconsistent with the disclosures of the ‘212 Patent.

As adopted by the District Court, a brake link on the lateral sides of a frame member that “passes” the frame member must occupy a position both in front of the rear most and front most boundaries of the frame member. A24-27. However, the specification of the ‘212 Patent clearly uses the term “passes” to describe the position of the brake link with relation to the rear wheel: “The brake link 2 can consist of a … double sided strut that passes next to both sides of a rear wheel 17.” A84. Therefore, just as the rear end of the brake link is situated laterally to both sides of the rear wheel, the front end of the brake link is situated laterally to both sides of the frame member.

A person of ordinary skill reading the ‘212 Patent would not understand “passes” to require the brake link to “extend beyond” the front and rear most boundaries of the frame member. Rather, a person of ordinary skill would

understand "passes" to mean, "moves next to or beyond." A3742-3746. This understanding is consistent with the '212 Patent's figures. Figure 4 shows that the brake link does not "extend beyond" the boundary of the rear wheel, even though the specification states that it "passes on both sides of a rear wheel:"

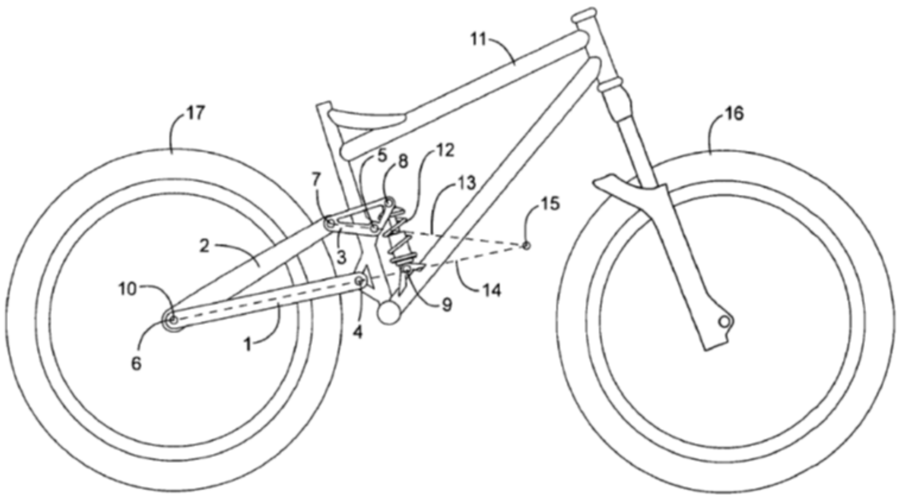


FIGURE 4

A78. If the District Court's construction were applied to the brake link with regard to the rear wheel, as it ostensibly would apply to the frame member, the preferred embodiments in the '212 Patent would have to be configured as follows:

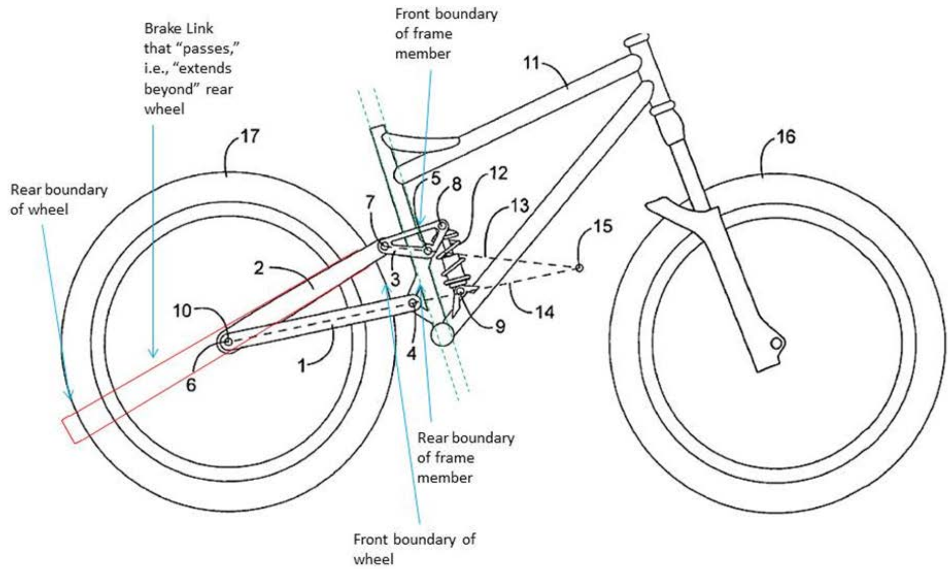


FIGURE 4

The District Court also erroneously concluded that "frame member" did not include the components of a suspension system. A32. This ignored the '212 Patent's specification which states, "the frame 11 provides a support or mounting location for powertrain components such as gears …; [and] suspension parts such as forks, rear suspension, and front suspension…." A83. It further describes a "frame" as being comprised of, among other things, "seatstays, chainstays, a seatstay, a chainstay…." A90. Indeed, the links described in the '212 Patent specification comprise the only support locations for rear gears and derailleurs, the brake link, all critical components of the powertrain, and suspension systems.

With regard to the '301 Patent, the District Court erroneously construed the limitation "change in slope value" to mean "change between positive, negative, or

zero slope." A56-59. However, this construction ignored relevant language from the '301 Patent and excludes certain disclosed embodiments of the invention. Correctly construed, "change in slope value" means "change in the slope of a curve plotted on a Cartesian graph where slope is the change in Y value divided by the change in X value over an identical and correlating small incremental wheel travel distance." A3787-3788.

Independent claim 29 of the '301 Patent refers to a leverage ratio curve with a "negative or positive slope" in the beginning and end thirds of the curve, with a "change of slope value" in the middle third. A131-132. While certain dependent claims required a change from a negative to a positive slope, or a positive to a negative slope, no independent claims contain such a limitation. *See* A132. Therefore, the plain language of the specification supported a construction defining "change in slope value" as the change in the steepness of the curve.

The District Court also construed "has a negative or a positive slope" as "has only a negative or a positive slope, and does not include both a negative and a positive slope or a zero slope." A51-56. This construction excluded bicycles having a leverage rate curve that varies from negative to positive, or with a zero slope, in the beginning and end thirds.

Both parties acknowledged that the specification discloses embodiments where the beginning and end thirds of the leverage ratio curves are not limited to

either a positive or negative slope. A53. The '301 Patent discloses embodiments having both a negative and positive slope in the same one third of the leverage ratio curve:

> In certain embodiments, a beginning 1/3 can comprise a positive slope, zero slope, *and or* a negative slope. In certain embodiments, a middle 1/3 can comprise a positive slope, zero slope, and *or a* negative slope. In certain embodiments, an end 1/3 can comprise a positive slope, zero slope, *and or* a negative slope.

A130. Rather than construe the claims to give effect to this language, the District Court applied the doctrine of prosecution history estoppel to admittedly exclude preferred embodiments of the invention. A53-56.

Based on its constructions of the Mounting and Shock Absorber Markush terms, the District Court found that none of the Full Floater-equipped bicycles literally met the Mounting and Shock Absorber Markush terms, and found that the ABP-equipped bicycles did not literally meet the Shock Absorber Markush term. A59-62. Based upon its construction of the Shock Absorber Markush term and the terms "has a negative or positive slope" and "change in slope value," the District Court granted summary judgment of non-infringement with regard to all asserted claims of the '301 Patent. A66-69.

The District Court also granted summary judgment of non-infringement under the doctrine of equivalents on the '212 Patent. A62-66. This was based on a fundamental misunderstanding of Split Pivot's doctrine of equivalents argument.

With respect to the Mounting Markush term, the District Court asserted "Split Pivot has not proposed any facts suggesting that Trek's Full Floater bicycles, with shock absorbers mounted to two links, achieve substantially the same results in substantially the same way as the suspension system of the *claimed invention*." A63 (emphasis in original). This finding was wrong, because Split Pivot presented substantial evidence that that Trek's Full Floater bicycles perform substantially the same function, in substantially the same way, and achieve substantially the same result as a bicycle without a floating shock arrangement. A2116-2122; A3766-3767.

Based solely upon its findings of non-infringement, the District Court granted Trek's motion for summary judgment of no willful infringement. A71. Due to its finding that the Accused Bicycles did not infringe, the District Court did not address the voluminous evidence of willful infringement presented by Split Pivot. *Id.*; *see also* A3822-3826.

SUMMARY OF ARGUMENT

The District Court violated multiple canons of claim construction. Its erroneous claim construction excludes every preferred embodiment of the '212 Patent from the scope of the claims. It also construed an expressly claimed embodiment – utilizing a compression gas spring – out of existence. Such constructions are rarely, if ever correct, and certainly are not correct here.

This erroneous claim construction resulted from the District Court's incorrect interpretation of this Court's precedents. The District Court eschewed normal claim construction procedures, instead holding that Markush group terms *must* be construed to mean "one, and only one." No such rule exists. Moreover, the District Court wrongly found that the presence of more than one Markush group member in an accused device, even if each member was independently sufficient to meet the claimed element, precluded infringement.

As with its construction of the '212 Patent, the District Court erroneously construed limitations of the '301 Patent contrary to the specification and plain mathematical principles, and thereby excluded disclosed embodiments of the invention. The District Court also erroneously applied prosecution history estoppel to rewrite the scope of the '301 Patent.

Finally, the District Court erroneously dismissed Split Pivot's willful infringement claim. In light of the substantial evidence that Trek intentionally sold

its accused products with knowledge of the Patents, Trek acted despite an objectively high likelihood that its actions constituted infringement of a valid patent, and that risk was known to Trek. The District Court's finding of no willful infringement therefore must also be reversed.

STANDARD OF REVIEW

This Court reviews claim construction *de novo*. *Lighting Ballast Control LLC v. Philips Electronics N.A. Corp.*, 2014 U.S. App. LEXIS 3176 at *49-50 (Fed. Cir. 2014) (*en banc*).[1] Regarding willful infringement, this Court reviews the first prong of the inquiry, whether an "infringer acted despite an objectively high likelihood that its actions constituted infringement of a valid patent," *de novo*. *Power Integrations, Inc. v. Fairchild Semiconductor Int'l, Inc.*, 711 F.3d 1348, 1356-1357 (Fed. Cir. 2013). The second prong of the willfulness inquiry, whether the objectively defined risk "was either known or so obvious that it should have been known to the accused infringer," is reviewed for substantial evidence. *Id*. at 1357.

[1] The Supreme Court has recently granted certiorari in *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 723 F.3d 1363 (Fed. Cir. 2013), to address whether a district court's factual finding in support of a claim construction may be reviewed *de novo*. *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 2014 U.S. LEXIS 2312 (U.S. Mar. 31, 2014). The Supreme Court's ruling in *Teva* should not impact this case, because the District Court did not make any findings of fact with respect to its claim constructions.

ARGUMENT

I. THE DISTRICT COURT'S CLAIM CONSTRUCTION WAS ERRONEOUS.

The District Court construed the Markush Group Claim Terms erroneously and thereby excluded all the preferred embodiments from the scope of the claims. The District Court wrongly construed each of these limitations to allow "one, and only one" of the recited shock absorbers and links.

A. The District Court Erred In Construing The Markush Group Claim Terms.

The District Court found that none of Trek's Accused Bicycles met the Shock Absorber Markush term because each bicycle includes more than one member of the Markush group, *i.e*., a compression gas spring or coil spring (functioning as impact absorption elements) *and* a fluid (functioning as a damping element). A61. The District Court also found that Trek's Full-Floater bicycles did not satisfy the Mounting Markush term because each accused bicycle includes a shock absorber attached to two links – the control link *and* the brake link. *Id*.

The District Court's construction of these Markush group claim terms is erroneous. Its construction of the Shock Absorber Markush term excludes every preferred embodiment of the Patents. It also excludes an expressly claimed invention utilizing a compression gas spring. The construction of the Mounting Markush term excludes a shock absorber mounted to two links, which is expressly

disclosed in the Summary of the Invention, and disregards statements that singular terms were to be construed to include the plural and that the invention was not limited by the specific embodiments described in the Patents.

The District Court's construction of the Markush group terms was erroneous because of its overly broad interpretation of *Abbott Laboratories v. Baxter Pharmaceutical Products, Inc.*, 334 F.3d 1274, 1280 (Fed. Cir. 2003). *Abbott Labs.* does not support the District Court's construction. In *Abbott Labs.*, this Court considered the construction of a claim for an anesthetic composition that included a Markush group:

> *a Lewis acid inhibitor in an amount sufficient to prevent degradation* by a Lewis acid of said quantity of sevoflurane, said Lewis acid inhibitor *selected from the group consisting of* water, butylated hydroxytoluene, methylparaben, propylparaben, propofol, and thymol.

Abbott Labs., 334 F.3d at 1276 (emphasis added). The patentee sought a construction that would allow it to combine non-infringing levels of two Lewis acid inhibitors into an infringing mixture. *See id*. According to the patentee, combining two Lewis acid inhibitors from the listed Markush group, even if not individually present in an effective amount, would provide an effective aggregated amount of Lewis acid inhibitors to support a finding of infringement. *See id*. at 1282-83. This Court rejected that proposed construction, noting that "[i]f a patentee desires mixtures or combinations of its members of the Markush group,

the patentee would need to add qualifying language [*e.g.*, "and mixtures thereof"] while drafting the claim." *Id*. at 1281.

Upon finding that the patentee had not included such qualifying language, this Court found that the claims had two requirements: "[1] a single Lewis acid inhibitor selected from the recited Markush group, and [2] present in an amount effective to prevent degradation…." *Id*. It further noted:

> To prove literal infringement on remand, [the patentee] must show [1] *a* species selected from the members of the cited Markush group is present in [the accused infringer's] sevoflurane composition [and 2] *in an amount effective to function as a Lewis acid inhibitor*.

Id. at 1283 (emphasis added). *Abbott Labs.*, therefore, stands for the narrow proposition that a patentee cannot aggregate multiple members of a Markush group to support a finding of infringement. It does not establish a rule that if the alleged infringer had enough of two members of a claimed Markush group to independently infringe, the presence of more than one Markush group member would negate infringement.

The District Court failed to recognize this narrow scope, and interpreted *Abbott Labs.* more expansively, holding that in the absence of qualifying language specifically providing for "mixtures" and the like, the Markush group must be construed to mean "one, and only one" element selected from the group. A37-40. *Abbott Labs.* did not create any such claim construction rule. The phrase "one, and only one" does not appear in *Abbott Labs*. *See Abbott Labs.*, 334 F.3d at 1281-83.

Rather, *Abbott Labs.* stated that the asserted claim was limited to "a single Lewis acid inhibitor selected from the recited Markush group, *and present in an amount effective to prevent degradation* … of sevoflurane." *Id.* at 1281 (emphasis added). This second part of the construction made clear that contrary to the patentee's contention that two members of the Markush group could be combined to achieve an effective amount and thus find infringement, infringement would only be found if (1) a member of the Markush group was present and (2) that member was present in an effective amount to prevent degradation of sevoflurane. Thus, the presence of additional Markush group members would not nullify infringement.

The claim construction analysis in *Abbott Labs.* and subsequent cases underscore the error in the District Court's construction. If, as the District Court held, the use of a singular article in conjunction with a Markush group required "one, and only one" member of the Markush group [A35-40], then no further review of the intrinsic record would have been necessary. *Power Integrations, Inc.*, 711 F.3d at 1361.

In *Abbott Labs.*, this Court did not end its claim construction inquiry after reading the claim language "a Lewis acid inhibitor." Rather, it only determined the proper claim construction after reviewing the intrinsic evidence, specifically the prosecution history. *See Abbott Labs*., 334 F.3d at 1281. This Court's review of

the intrinsic evidence in *Abbott Labs.* shows that a Markush group claim term does *not* have an "ordinary meaning," and that its meaning is *not* necessarily clear from the claim language.

Similarly, in *Norian Corp. v. Stryker Corp.*, 432 F.3d 1356 (Fed. Cir. 2005), this Court construed, "a solution consisting of water and a sodium phosphate, where the concentration of said sodium phosphate in said water ranges from 0.01 to 2.0M and said solution has a pH in the range of about 6 to 11." *Id*. at 1357. This Court affirmed the construction of "said sodium phosphate" to mean "a single type of sodium phosphate." *Id*. at 1361. It did not do so, however, based on the rigid application of a rule that a Markush group means "one, and only one." Rather, this Court construed this limitation by following established claim construction methodology, *i.e.*, by reviewing the language of the claims, the specification, and the prosecution history. *See id*. at 1359-1361.

In *Norian*, this Court first reviewed the language of the claims. It noted that while claim 8 referred to "a sodium phosphate," it also referred to "at least one calcium source, and at least one phosphoric acid source." *See id*. at 1359. If this limitation was intended to claim at least one type of sodium phosphate, "it would have been simple to use the same language in the second portion of the claim that was used in the first." *Id*.

The Court also noted "the claim language 'consisting of a … sodium phosphate,' on its own, *suggests* the use of a single sodium phosphate." *Id*. at 1359 (emphasis added). The choice of the word "suggests" rather than "requires" or other similar mandatory language demonstrates no rule exists requiring a Markush group to mean "one and only one." That conclusion is emphasized by this Court's subsequent finding that its "*interpretation* [of 'a sodium phosphate'] is consistent with the specification.…" *Id.* (emphasis added). This Court also observed "nowhere in the specification does the patentee refer, *either explicitly or implicitly*, to making the claimed solution from a mixture of multiple sodium phosphates." *Id*. (emphasis added). The recognition that the specification lacked any "explicit[] or implicit[]" reference to a solution including a mixture of sodium phosphates demonstrates that had any such reference existed, this Court's construction may have been different.

After reviewing the specification, this Court analyzed the prosecution history, pointing out that the district court had been "correct to rely on the prosecution history." *Id*. The *Norian* Court found that the prosecution history included a series of patentability rejections, narrowing amendments, and clarifying statements by the patentee. *Id*. That recognition led this Court to affirm the district court's construction, noting, "references in the prosecution history

underscore the restrictive scope that was accorded to the claim language." *Id*. at 1361.

Ultimately, this Court rejected the claim construction argument offered by the patentee, because the argument "does not change the clear effect of the prosecution history, the specification, and the claim language." *Id*. at 1362. This summary of the Court's claim construction in *Norian* demonstrates a Markush group claim language does *not* necessarily require the "one, and only one" limitation as the District Court ruled here. Rather, Markush group claims must be construed according to the same procedures as any other claim.

Other district courts have recognized the proper, narrow scope of *Abbott Labs*. In *Teva Pharmaceuticals USA, Inc. v. Amgen, Inc*., 2010 WL 3620203 (E.D. Pa. Sept. 10, 2010), the district court construed the limitation "having an amino acid sequence selected from the group consisting of … [an enumerated sequence]." *Id*. at *6. The patentee argued that "selected from the group consisting of" was a term of art that closes the set to those listed members of the Markush group but that nothing in the claim term excluded two or more of the recited sequences from being within the claim scope. *See id*. The accused infringer argued that use of "an" with "consisting of" meant that the patent was limited to "one and only one"

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of the three amino acid sequences listed. *See id*. at *8. The district court rejected the infringer's construction.[2] *Id*.

In *Bristol-Myers Squibb Co. v. Apotex, Inc*., 2013 WL 1214733 (D.N.J. March 28, 2013), the district court construed "[a] compound or salt thereof selected from the group consisting of [an enumerated list]." *Id*. at *3. The accused infringer relied on *Abbott Labs.* to argue that "[a]ny substance that mixes two compounds on the list (whether or not as an impurity), or mixes one compound on the list and one off the list, is outside the scope of the claim language." *Id*. at *8. The district court rejected the accused infringer's proposed construction and instead relied on the patent claims and specification to find that the Markush group language included "any pharmaceutical composition containing a compound listed in the claim." *Id*.

Par Pharmaceuticals, *Inc. v. TWI Pharmaceuticals*, *Inc.*, 2013 WL 3777028 (D. Md. July 17, 2013), reached a similar conclusion. The accused infringer argued that according to *Abbott Labs.*, it could not infringe the asserted claim because "its drug, with an assumed 29% difference, impermissibly meets the claim

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[2] The District Court here addressed *Teva* in a cursory fashion, concluding, "to the extent that the *Teva Pharmaceuticals* court's reasoning is applicable, it is for the proposition that a Markush group indicates a single member of the group *carries out the given function*." A36 (emphasis in original). *Teva* does not support this interpretation. Moreover, here the District Court did not identify the "given function" of the shock absorber in the '212 Patent. *See generally* A40-44.

under multiple members of the Markush group." *Id*. The district court disagreed, explaining:

> *Abbott Labs* stands only for the proposition that one cannot aggregate members of the Markush group to meet a claim…. There is no indication [in *Abbott Labs.*] that, if the alleged infringer had enough of two "Lewis acid inhibitor" members of the Markush group to each independently infringe the claim, the presence of multiple Markush group members would have somehow nullified its infringement.

Id.

Thus, *Abbott Labs*. does not require a claim construction that "one, and only one" member of a Markush group may be present in an infringing article. As the courts in *Teva, Bristol Myers-Squibb,* and *Par* all properly recognized, the single Markush group member limitation from *Abbott Labs.* only applies when a patentee seeks to aggregate or combine multiple Markush group members that would not, by themselves, infringe. The District Court erroneously interpreted *Abbott Labs.* to create a rule of claim construction that Markush group claims must be read to cover "one, and only one." Rather, as this Court's analysis in *Abbott Labs*. and *Norian* demonstrates, Markush group claim terms, even those modified by singular articles, must be construed through usual construction methodologies.[3] *See Power Integrations, Inc.*, 711 F.3d at 1361; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005).

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[3] Moreover, indefinite articles "a" and "an" mean "one or more" when used in open-ended claims. *See Baldwin Graphic Sys., Inc. v. Siebert, Inc.*, 512 F.3d 1338, 1342 (Fed. Cir. 2008). "The exceptions to this rule are extremely limited: a patentee must evince[] a clear intent to limit 'a' or 'an' to 'one.'" *Id*. This general rule "does not apply when the specification or the prosecution history shows that the term was used in its singular sense." *Norian Corp.*, 432 F.3d at 1359. "In particular, this [C]ourt has interpreted the word 'a' in its singular sense when … it has been used in conjunction with the closed transitional phrase 'consisting of.'" *Id*.

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B. The District Court Erred In Construing "Wherein Said Shock Absorber Is Selected From The Group Consisting Of A Compression Gas Spring, A Leaf Spring, A Coil Spring, And A Fluid."

The District Court construed the Shock Absorber Markush term, which appears in each asserted claim of the '212 Patent, to mean "wherein said shock absorber consists of one, and only one, of the following: a compression gas spring, a leaf spring, a coil spring, and a fluid." A40-41; A43. Contrary to the District Court's construction, the Shock Absorber Markush term should be construed as: "wherein said shock absorber consists of one or more, of a compression gas spring, a leaf spring, a coil spring, and a fluid." A40-41.

1. The District Court's Construction Excludes Every Preferred Embodiment of the '212 Patent.

The parties agreed that the term "shock absorber" is well known in the art to include both a spring and a fluid damper. A41-42. Nevertheless, the District Court construed this term to exclude shock absorbers having *both* a spring and a fluid damper, thereby excluding every preferred embodiment of the '212 Patent.

A claim construction that excludes a preferred embodiment "is rarely, if ever, correct and would require highly persuasive evidentiary support." *Accent Packaging, Inc. v. Leggett & Platt, Inc.*, 707 F.3d 1318, 1326 (Fed. Cir. 2013). Indeed, "it is unlikely that an inventor would define the invention in a way that excluded the preferred embodiment, or that persons of ordinary skill in th[e] field

would read the specification in such a way." *Hoechst Celanese Corp. v. BP Chem. Ltd*., 78 F.3d 1575, 1581 (Fed. Cir. 1996).

The District Court noted "in order to interpret the words of the claims, courts look to 'the intrinsic evidence of record, including the written description, the drawings, and the prosecution history, if in evidence.'" A14-15. "[P]atent drawings illustrate the invention and generally represent preferred embodiments of the invention." *Outside the Box Innovations, LLC v. Travel Caddy, Inc.*, 695 F.3d 1285, 1310 (Fed Cir. 2012) (Newman, J., dissenting in part). "The purpose of patent drawings is to focus the subject matter on which a patent is sought." *See id*. In the absence of prosecution disclaimer, which requires a clear and unmistakable disavowal during prosecution, "[i]t is highly unusual to construe routine patent claims so as to exclude the embodiments in the drawings." *Id*. This is particularly the case when such a construction would exclude *all* preferred embodiments. *See, e.g.*, *Accent Packaging, Inc.*, 707 F.3d at 1325-26 ; *Glaxo Group Ltd. v. Apotex, Inc*., 376 F.3d 1339, 1347 (Fed. Cir. 2004); *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1583 (Fed. Cir. 1996).

The District Court recognized that the specification of the '212 Patent discloses two preferred embodiments: "[I]n figures 1 and 3, the shock absorber is mounted to the brake link on one side and the frame on the other; in figures 2, 4, 5,

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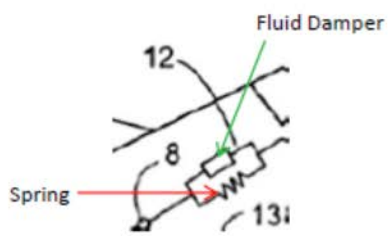
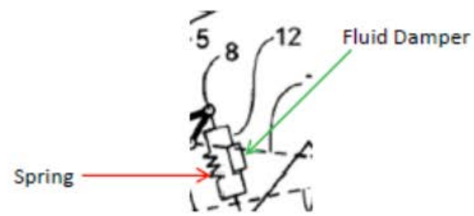
and 6, the shock absorber is mounted to the control link on one side and the frame on the other." A39; *see also* A84-A85.

In Figure 1 of the '212 Patent, "[t]he shock absorber is located at 12." A3. Figure 2 depicts the same shock absorber, using the same symbol, located at 12. A76.

Shock Absorber (12) from Fig. 1



Shock Absorber (12) from Fig. 2



A3; A76. The symbol used to illustrate "shock absorber 12" is the standard engineering symbol for a spring damper. *See* A7885-7917.

The District Court failed to define a person of ordinary skill in the art, but such a person would understand that the symbol used to portray the "shock absorber 12" includes both an impact absorption element (*i.e.*, a spring), and a damper (*i.e.*, a fluid).[4] Trek has defined a person of ordinary skill as having "five

[4] Claims are to be construed through the eyes of a person of ordinary skill in the art. *See Phillips v. AWH Corp.*, 415 F.3d at 1313 . The District Court's failure to

years of experience in the mechanical arts, such as mechanical engineering or mechanism design, combining college level education and work experience." A1097. Such a person certainly would understand the meaning of standard engineering symbols.

A person of ordinary skill would recognize that every preferred embodiment of the '212 Patent, including those illustrated in Figures 3-6, represent the designs shown in Figures 1 and 2. Thus, every preferred embodiment includes a shock absorber having both a spring and fluid damper element. But the District Court's construction excludes shock absorbers having a spring and fluid damper. A42-44. Because that construction excludes every preferred embodiment, it cannot be correct.

The District Court also stated "the prosecution history suggests a narrower interpretation [of shock absorber] *may* be appropriate." A43 (emphasis added). It further concluded that the patentee "at least intentionally restricted the scope of his invention and intended only to claim systems including a shock absorber selected from" the enumerated Markush group. *Id.* Presumably, the District Court's offered these observations with prosecution history estoppel in mind.

"When narrowing claim scope, [this Court] has recognized that a clear and unmistakable disavowal during prosecution overcomes the heavy presumption that

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define a person of ordinary skill in the art further demonstrates the erroneous nature of its claim construction.

claim terms carry their full ordinary and customary meaning." *Plantronics, Inc. v. Aliph, Inc.*, 724 F.3d 1343, 1350 (Fed. Cir. 2013). Even upon a finding of such disavowal, "prosecution history disclaimer narrows the meaning of the claim consistent with the scope of the claim surrendered." *Id*.

The District Court did not expressly find prosecution history disclaimer or identify any language in the prosecution history that provided a clear and unmistakable disavowal of claim scope. Even if such a finding had been made, the District Court failed to identify the proper scope of any alleged surrender. Prior to amendment, the claims sought coverage for "a shock absorber." A3244-3251. The explanation accompanying the amendment stated that the claimed shock absorber was being made to "more particularly point out and more distinctly claim the subject matter." A3264. The amended claim language stated that the shock absorber was selected from a compression gas spring, a leaf spring, a coil spring, and a fluid. A3254. It did not disclaim a shock absorber having, for example, a compression gas spring *and* a fluid damper.

The Information Disclosure Statement ("IDS") filed concurrently with the amendment confirms this conclusion. A3268. The IDS identified marketing materials for 1994 model year Crestone Peak bicycles. *Id*. The Crestone Peak bicycles described in the IDS were not equipped with spring shocks, but instead had elastomers to provide front and rear suspension travel. A3771-3772. Crestone

Peak specifically differentiated its bicycles based on their use of elastomers over other compressive systems, like springs. A3270-3274.

Even if the District Court assumed, *arguendo*, that the amendment constituted a clear and unmistakable disavowal of claim scope, any resulting narrowing of scope must be limited to the subject matter disclaimed. *See Plantronics, Inc*., 724 F.3d at 1350-1351. That would only include the elastomers used to absorb bumps and provide "active self-damping" as disclosed in the Crestone Peak reference. *See id*. The District Court's construction that this amendment narrowed the scope of the claimed "shock absorber" to including "one, and only one" of the members of the Markush group exceeds the scope of any alleged surrender.

2. The District Court's Construction Reads an Express Limitation Out of the Claims.

The District Court's grant of summary judgment was based, at least in part, on its conclusion that none of the accused Trek bicycles infringed because they all included "air springs" or "compressed gas springs" *and* "fluid dampers." A61. Therefore, according to the District Court's reasoning, a compression gas spring cannot constitute a "shock absorber" if it includes "a fluid."

But gas is a fluid. This Court's predecessor recognized 45 years ago that "[f]luids, *including liquids and gases*, resist flow because the molecules comprising the fluid attract one another." *Barrett v. United States*, 405 F.2d 502,

513 (Ct. Cl. 1968) (emphasis added). The definition of fluid was the same in 2005, when the '212 Patent was conceived. In 2005, "fluid" was recognized as "[a] state of matter, *such as liquid or gas*, in which the component particles (generally molecules) can move past one another. Fluids flow easily and conform to the shape of their containers." *American Heritage Science Dictionary* 238 (1st ed. 2005) (emphasis added).

Because gas compression springs include a fluid, *i.e.*, a gas, they inherently include more than one of the elements listed in the Markush group. Under the District Court's construction, a vehicle equipped with a gas compression spring, even if lacking a separate damper, cannot infringe any claim of the '212 Patent. Thus, the District Court's construction of the Shock Absorber Markush Term reads "gas compression spring" out of every claim of the '212 Patent.

"Courts do not rewrite claims; instead, [courts] give effect to the terms chosen by the patentee." *K-2 Corp. v. Salomon S.A.*, 191 F.3d 1356, 1364 (Fed. Cir. 1999). Similarly, "courts can neither broaden nor narrow claims to give the patentee something other than what he has set forth." *Texas Instruments v. United States Int'l Trade Comm'n*, 988 F.2d 1165, 1171 (Fed. Cir. 1993). It is, therefore, improper to construe the claims of the '212 Patent in a manner that reads "gas compression spring" out of existence.

Thus, the District Court erred in its construction of the Shock Absorber Markush term. Properly construed, all of Trek's Accused Bicycles meet the Shock Absorber Markush term, because every bicycle uses a shock that comprises a compressed gas or coil spring combined with a fluid damper. A2126.

C. <u>The District Court Erred In Construing "Wherein Said Shock Absorber Is Mounted To A Link Selected From The Group Consisting Of A Brake Link, A Control Link, And A Wheel Link."</u>

The District Court construed the Mounting Markush term to mean: "wherein said shock absorber is mounted to one, and only one, link selected from the group consisting of a brake link, a control link, and a wheel link." A40-43. However, the Mounting Markush term should be construed as: "wherein said shock absorber is mounted to one or more links selected from the group consisting of a brake link, a control link, and a wheel link." A33.

Contrary to the teachings of *Abbott Labs* and *Norian*, the District Court dismissed the specification of the '212 Patent. A38. In *Abbott Labs* and *Norian*, this Court exhaustively reviewed the intrinsic record for any "explicit[] or implicit[]" reference to a patentee's intention to cover more than one Markush group element, and found no such reference. *See Norian Corp.*, 432 F.3d at 1360. Here, the intention that the shock absorber can be mounted to more than one of the recited links is explicitly stated in the '212 Patent.

The Summary of the Invention states, "In certain embodiments, a shock absorber is mounted to a brake link ***and/or*** a control link in a pivotal manner." A82 (emphasis added). The '212 Patent specification further states: "[t]hroughout this application the singular includes the plural and the plural includes the singular, unless indicated otherwise." A91. Based on these disclosures, a person of ordinary skill would understand that the invention claimed a shock absorber that could be mounted to two, *i.e*., "one or more," links. The District Court dismissed these disclosures and disregarded how a person of ordinary skill would understand them. A38-39.

In *Rexnord Corp. v. Laitram Corp*., 274 F.3d 1336 (Fed. Cir. 2001), this Court construed the term "portion," choosing between a narrow construction limited to parts of an object that are "separate" and a broader construction providing that parts could be either "separate" or "integral." *Id*. at 1341. In doing so, this Court focused on the Summary of the Invention, which described the actual invention rather than preferred embodiments. *See id*. at 1345, 1348. In *Rexnord*, every preferred embodiment in the specification was described or illustrated in a manner that was consistent with the construction proposed by the accused infringer. *See id*. at 1344-45. Despite that, two of the three embodiments in the Summary of the Invention were not limited in a way that supported the narrower

construction.[5] *See id*. at 1345. That fact, plus the patentee's statement in the written description that "the invention is not limited in its application to the details of construction and arrangements of components set forth in the following description or illustrat[ions]" led this Court to adopt the construction proposed by the patentee. *See id*. at 1348.

The analysis from *Rexnord* is applicable here. Here the Summary of the Invention expressly describes a shock absorber mounted to two links: "a shock absorber is mounted to a brake link ***and/or*** a control link. . . ." A82 (emphasis added). This is a description of the *invention*, not just a preferred embodiment. Moreover, the '212 Patent states:

> The present invention is not to be limited in scope by the specific embodiments described herein…. [V]arious modifications of the invention, in addition to those shown and described herein, will become apparent to those skilled in the art … [and] [s]uch modifications are intended to fall within the scope of the appended claims.

A91. The '212 Patent also instructs, "the singular includes the plural and the plural includes the singular, unless indicated otherwise." A91.

Inventors are not required to describe in the specification every conceivable and possible future embodiment of their inventions. *See SRI Int'l v. Matsushita*

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[5] This Court found that the two embodiments described in the Summary of the Invention did not include "any words that connote a quality of being 'separate.'" The absence of any such connotation led this Court to find that these embodiments were broader than the other embodiment from the Summary of the Invention. *See id*. at 1345.

Elec. Corp. of Am., 775 F.2d 1107, 1121 (Fed. Cir. 1985) (*en banc*). The inventions claimed in the '212 Patent, by its express terms, includes a shock absorber mounted to two links. The '212 Patent also states that it is not limited to the preferred embodiments and that singular terms, *e.g.*, "link," include the plural. The District Court ignored these facts and erred in construing the Mounting Markush term to cover only shock absorbers that are mounted to "one, and only one" of the enumerated links.

The District Court also ignored what these disclosures communicate to a person of ordinary skill. Trek's expert admitted that a person of ordinary skill would know that a shock absorber could be mounted to more than one of the links selected from the Markush group:

> *From the specification, **one of ordinary skill in the art would understand that the shock could be connected to*** the brake link and the frame, the control link and the frame, or ***the brake link <u>and</u>/or the control link***….

A809 (emphasis added). The District Court ignored this admission. *Compare* A2524-2525 *with* A33-40.

Failing to consider the admission of Trek's expert was improper. Extrinsic evidence in the form of expert opinion can be highly relevant to claim construction. In *AIA Eng'g Ltd. v. Maggoteaux Int'l S/A*, 657 F.3d 1264, 1277-78 (Fed. Cir. 2011), for example, two opposing experts agreed that a person of ordinary skill would have known that the alleged infringer's proposed construction

of a claimed chemical solution was not physically possible. This Court characterized the experts' agreement as "particularly enlightening" because it demonstrated that the patentee must have intended to apply a special meaning to the claim term. *Id*. at 1277. Here, Split Pivot's and Trek's experts agreed that a person of ordinary skill would know from the specification that a shock absorber could be mounted to two of the links enumerated in the Markush group. *See* A809; A2073-2074.

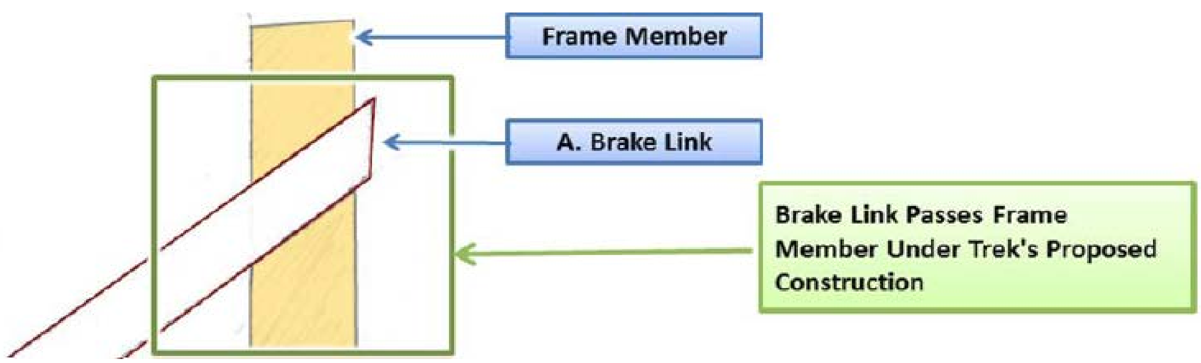
Persons of ordinary skill are presumed to be aware of all pertinent prior art. *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc*., 807 F.2d 955, 962 (Fed. Cir. 1986). Such a person would understand that a shock absorber could be attached to more than one moveable link. As explained by Split Pivot's expert, two-wheeled vehicles having a shock mounted in a "floating" configuration dated to at least 1980. A2116-2117. One of the bicycles using a floating shock mounted between two moveable links was designed by Weagle and sold in 2004. *See id*.; *see also* A2026-2041.

A person of ordinary skill would have known after reading the '212 Patent that the shock absorber could be mounted to more than one of the enumerated links. *See Custom Accessories, Inc.*, 807 F.2d at 962. Construing the Mounting Markush term to cover a shock absorber attached to "one, and only one" of the enumerated links impermissibly rejects this knowledge.

D. The District Court Erroneously Construed "Brake Link Passes On Two Sides Of A Frame Member."

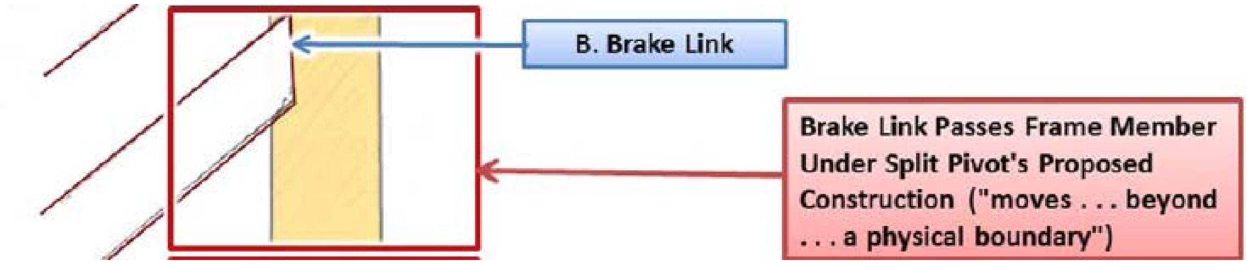
Although its finding of non-infringement was not based on this construction, the District Court construed "brake link passes on two sides of a frame member" in asserted independent claims 1 and 43 of the '212 Patent to mean the "brake link extends beyond both lateral sides of a structural support for components of a suspension system." A24; A27. This limitation should properly be construed to mean the "brake link that moves next to or beyond two sides of a physical boundary of a frame member." A24.

The District Court's construction of "passes" is inconsistent with the specification. According to Trek, a brake link on the lateral sides of a frame member that "passes," *i.e.*, "extends beyond" the frame member, must occupy a position in front of the rear-most *and* front-most boundaries of the frame member. Trek illustrated its contention as follows:



A2799. In contrast, a brake link situated on the lateral sides of the frame member that occupies a position forward of the rear-most boundary of the frame member,

but *not* forward of the front-most boundary, is inconsistent with Trek's proposed requirement that "passes" means "extends beyond."



Id. Split Pivot's proposed construction that "brake link passes on two sides of a frame member" means "brake link that moves next to or beyond two sides of a physical boundary of a frame member" is the proper construction.

The '212 Patent specification uses the term "passes" to describe the brake link vis-à-vis the rear wheel: "The brake link 2 can consist of a … double sided strut that *passes* next to both sides of a rear wheel 17." A84. Just as the front end of the brake link is situated on the lateral sides of the frame member, the rear end of the brake link is situated on the lateral sides of the rear wheel. *Compare* A91 *with* A84. Because the claims and the specification describe a brake link that "passes" on the lateral sides of two structures – a "frame member" and the rear wheel – a person of ordinary skill would understand "passes" to have the same meaning in both contexts.

Such a person would not understand "passes" to require the brake link to "extend beyond" the front *and* rear-most boundaries of the frame member. The

brake link, which passes on the lateral sides of the rear wheel, is depicted in Figures 1-4 as extending rearward from the control link, occupying a position behind the front-most boundary of the wheel, but terminating in the middle of the wheel at its wheel rotation axis 10. A78.

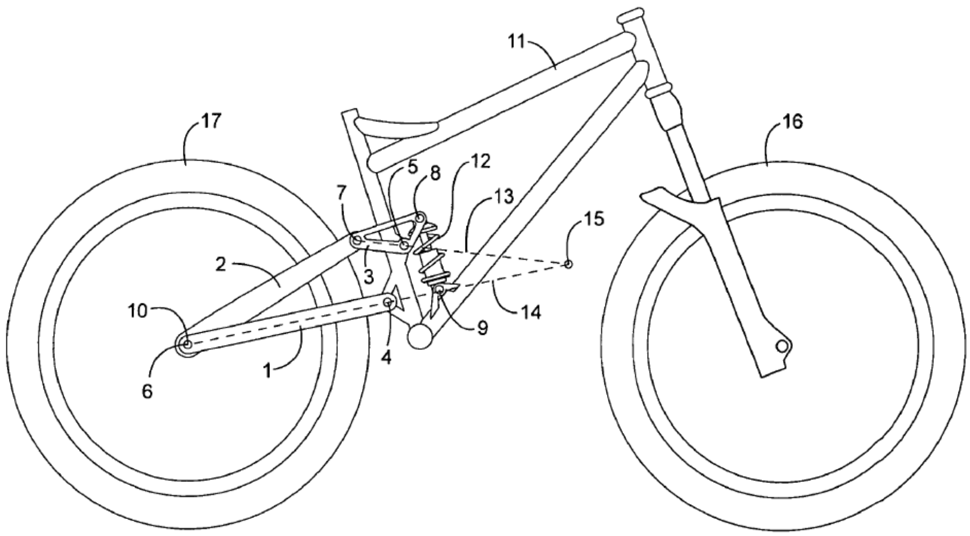


FIGURE 4

The brake link does not "extend beyond" the wheel, which would require it to move rearward to occupy a position in front of *and* behind the wheel's front and rear-most boundaries. If the District Court's construction of "passes" were applied to the brake link vis-à-vis the rear wheel, the preferred embodiments would have to be configured with the brake link extending beyond the rear boundary of the rear wheel:

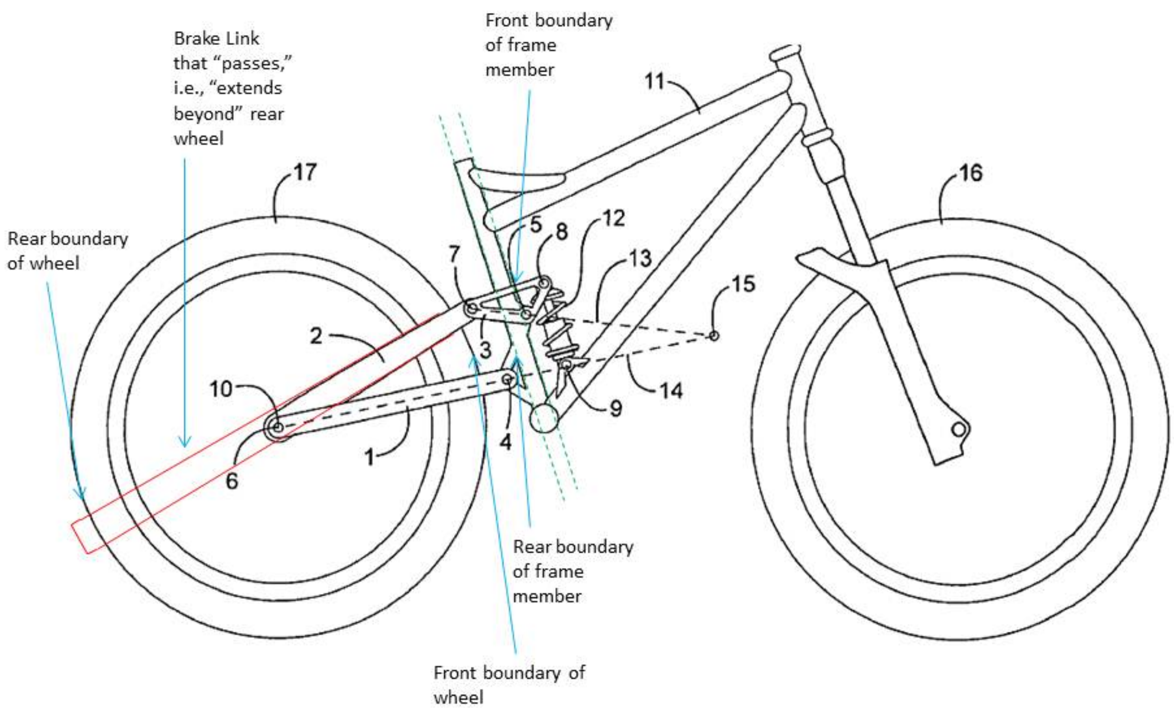


FIGURE 4

However, the District Court concluded that the specification supported Trek's proposed construction: "[t]he drawings in the '212 patent contain a brake link that not only 'moves next to' the rear wheel but also extends entirely beyond it on both lateral sides of the wheel *at the front end*."[6] A26 (emphasis added).

[6] The District Court misunderstood Split Pivot to argue that the "front and back ends of the wheel" were the "sides" for purposes of its contention. It then noted that Split Pivot "cannot ask the court to construe 'passes' consistently throughout the patent while asking it to construe 'sides' differently...." A26. Split Pivot made no such request. A3742-3748. The "sides" of the rear wheel are the same as the "lateral sides" of the frame member. Split Pivot has never contended that the "sides" of the rear wheel are the same as the "front and back ends of the wheel." *Id*.

According to Trek, if the brake link is only positioned forward of the rear-most boundary of the frame member, but not forward of the front-most boundary, then the brake link does not "extend beyond" the frame member. A2798. Similarly, a brake link positioned rearward of the front-most boundary of the rear wheel, but not rearward of the rear-most boundary, would not "extend beyond" the rear wheel, as required by the District Court's construction. If "passes" is construed to mean "extends beyond," then the brake links illustrated in Figures 1-4 do not "pass[]" the rear wheel.

The drawings of the '212 Patent demonstrate that "passes" does not require the brake link to "extend beyond" the frame member or the rear wheel. Rather, the brake link "passes" the frame member and the rear wheel if it moves "next to or beyond" these structures. This construction also is consistent with the ordinary meaning of "pass:"

> "to move in a particular direction or to a particular place or position" A4486;
>
> "to go; to move; to proceed; to be moved or transferred from one point to another…" A4490;
>
> "to go or move in the direction mentioned … to make something move in the direction or into the position mentioned" *Oxford Advanced Learners Dictionary*, http://oald8.oxfordlearnersdictionaries.com/dictionary/pass_1.

The meaning that is consistent with the use of "passes" in the claims and the specification is the proper construction. Split Pivot's proposed construction

reflects the ordinary meaning of "passes," encompasses the District Court's meaning, and is consistent with the use of that term in the claims *and* specification. It is, therefore, the correct construction. *See Thorner v. Sony Computer Entertainment Am., LLC*, 669 F.3d 1362, 1367 (Fed. Cir. 2012).

When construing "brake link passes on two sides of a frame member," the District Court also considered "frame member." A29-32. It erroneously concluded that "frame member" does not include the components of the suspension system. A32. This conclusion failed to consider all relevant passages of the '212 Patent's specification and relied heavily on the opinion of Trek's expert, which it ignored in similar contexts.

The specification states that "the frame 11 provides a support or mounting location for powertrain components such as … gears …; [and] suspension parts such as forks, rear suspension, and front suspension…." A83. It further describes a "frame" as being comprised of, among other things, "seatstays, chainstays, a seatstay, a chainstay…." A90. Also, "a moving suspension component of a suspension system" may include, among other things, "a link" and "linkages." A90-91. A "powertrain component of a suspension of the invention" may include, among other things, a "gear," and a "rear derailleur." A91. Each of these passages supports a construction of "frame member" that covers the claimed suspension links. The wheel link and control link also provide the exclusive support and

mounting locations for the brake link, which is part of the rear suspension. A83; A90-91. Without these links, the brake link would have nothing to mount to and nothing to use for support. *Id*. A person of ordinary skill would understand that the claimed suspension links, and the wheel link in particular, are frame members because they support and provide a mounting location for powertrain and suspension components of the patented design.

Notwithstanding these facts, the District Court relied on the unsupported opinion of Trek's expert that a person of ordinary skill would not understand "chainstay(s)" and "seatstay(s)" to refer to a "wheel link" and "brake link," respectively. A31. Based on the opinion of Trek's expert, the District Court concluded there was "no support for Split Pivot's construction that a 'frame member' includes the wheel link, brake link, and control link." A32. A proper construction, which considers the entire specification and is not based on the opinion of Trek's expert, requires a finding that the claimed suspension links, including, at a minimum, a wheel link, is a "frame member."

E. "Change In Slope Value."

Regarding the '301 Patent, the District Court erroneously construed "change in slope value" to mean "change between positive, negative, or zero slope." A56-59. In doing so, it substituted a narrow reading of the specification over well-recognized mathematical terms that would have been obvious to one of ordinary

skill. Correctly construed, "change in slope value" means "change in the slope of a curve plotted on a Cartesian graph where slope is the change in Y value divided by the change in X value over an identical and correlating small incremental wheel travel distance." A3787.

The District Court agreed with Trek that "change in slope value" referred not to the magnitude or steepness of the curve's *slope*, *i.e.*, the rise over run, but rather to a change of slope *sign*. One example used by the District Court to support its construction is claim 35, which states in part, "wherein said leverage ratio curve of said suspension system has a negative slope in the beginning 1/3 (third) and a positive slope in the end 1/3 (third), and a change in slope value in the middle 1/3 (third)." A58; A132. According to the District Court, this suggested that the "change in slope value" referred to a change from a negative to a positive sign, or vice versa. A58.

But the District Court ignored that claim 35 is dependent on independent claim 29, which refers to a leverage ratio curve with a "negative or positive slope" in the beginning and end thirds of the curve, with a "change of slope value" in the middle. A131-132. The other examples relied upon by the District Court followed this same pattern – the independent claim *did not* require a change from a positive slope to a negative slope, or a negative to a positive, while various dependent iterations did. *See* A58; A132-135. Therefore, the plain language of the claims

supports a construction defining "change in slope value" as the change in the steepness of the curve, because claim 29, among others, allows for a positive slope in the beginning third, a positive slope in the end third, and a "change in slope value" in the middle. Indeed, the District Court's construction effectively precludes certain disclosed embodiments from the scope of the claims.

Not only is the District Court's construction inconsistent with the claims and embodiments, it is inconsistent with common sense. Imagine two ski slopes – an Olympic downhill course and a bunny hill. While both slopes are pitched downwards, *i.e.*, have a negative slope, it can hardly be said that their steepness, or their slope value, is the same. Moreover, the steepness of any ski slope may vary throughout the descent, which is yet another example of change in slope value. But under the District Court's construction, the change in slope is irrelevant unless it goes so far as to actually change sign. This is despite the District Court's recognition that slope is a "mathematical calculation." A58.

The District Court instead based its incorrect construction upon the purported "context provided by the dependent claims." A57. But this approach ignored the plain meaning of the independent claims that provided the basis for the dependent claims and also ignored general mathematical principles.

F. <u>"Has A Negative Or Positive Slope."</u>

The District Court construed "has a negative or a positive slope" as "has only a negative or a positive slope, and does not include both a negative and a positive slope or a zero slope." A51-56. As the District Court acknowledged, this construction excluded preferred embodiments disclosed in the '301 Patent. A54-55. The District Court reasoned that the doctrine of prosecution history estoppel justified such an extraordinary outcome, but the evidence did not support this conclusion. Correctly construed, "has a negative or positive slope" should mean "has a negative and/or a positive slope, and may include a zero slope."

As a threshold matter, the word "or" can mean "either" or "both." In *Kustom Signals, Inc. v. Applied Concepts, Inc.*, 264 F.3d 1326, 1330 (Fed. Cir. 2001), this Court affirmed the construction of "or" to mean "a choice between either one of two alternatives, but not both." This Court noted that the district court had analyzed the patent at issue, and found that "there is no basis whatsoever for believing that [the patentee] intended its usage of 'or' somehow to embrace 'and.'" *Id*. at 1331. Implicitly, this Court acknowledged that "or" could have been construed differently if the specification described an embodiment that encompassed both alternatives. This was reflected in Chief Judge Mayer's dissent, who acknowledged "the plain meaning of 'or can be 'either or both.'" *Kustom Signals, Inc.*, 264 F.3d at 1333 (Mayer, C.J., dissenting).

The ‘301 Patent specification discloses embodiments having both a negative and a positive slope, and in some cases a zero slope, in the same 1/3:

> In certain embodiments, a beginning 1/3 can comprise a positive slope, zero slope, and or a negative slope. In certain embodiments, a middle 1/3 can comprise a positive slope, zero slope, and or a negative slope. In certain embodiments, an end 1/3 can comprise a positive slope, zero slope, and or a negative slope.

A130. The ’301 Patent specification also describes other preferred embodiments:

> Certain preferred embodiments can comprise a beginning 1/3 with a negative slope, a middle 1/3 with a negative and zero slope, and an end 1/3 with a positive slope. Certain preferred embodiments can comprise a beginning 1/3 with a positive and negative slope, a middle 1/3 with a negative and zero slope, and an end 1/3 with a positive slope. Certain preferred embodiments can comprise a beginning 1/3 with a positive and negative slope, a middle 1/3 with a negative and zero slope, and an end 1/3 with a more negative slope.

A115. Split Pivot’s expert opined that a person of ordinary skill reading the specification would understand “has a negative or positive slope” to mean “has a negative and/or positive slope.” A2091-2092.

The District Court recognized that the ‘301 Patent discloses embodiments in which the beginning and end thirds of the leverage ratio curves are not limited to either positive or negative slopes. A53. But relying on *Elektra Instrument S.A. v. O.U.R. Scientific Intern., Inc.*, 214 F.3d 1302 (Fed. Cir. 2000), it held that prosecution disclaimer excluded “embodiments that may *include* a zero slope in the curve’s first and last thirds.” A54. This was erroneous.

"In order for the doctrine of prosecution disclaimer to apply, a statement in prosecution must constitute a clear and unmistakable disclaimer of claim scope." *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 723 F.3d 1363, 1373 (Fed. Cir. 2013). Allegedly disavowing statements must be "so clear as to show reasonable clarity and deliberateness." *Omega Eng'g, Inc. v. Raytek Corp.*, 334 F.3d 1314, 1325 (Fed. Cir. 2003). Indeed, there is a "heavy presumption that claim terms carry their full ordinary and customary meaning, unless it can [be] shown the patentee expressly relinquished claim scope." *Epistar Corp. v. ITC*, 566 F.3d 1321, 1334 (Fed. Cir. 2009).

During the prosecution of the '301 Patent, Split Pivot submitted claims reading:

> wherein said leverage ratio is exemplified as a curve, said curve having a slope, and said slope in a beginning 1/3 selected from the group consisting of a positive slope, a zero slope, and a negative slope, said slope in a middle 1/3 selected from the group consisting of a positive slope, a zero slope, and a negative slope, and said slope in an end 1/3 selected from the group consisting of a positive slope, a zero slope, and a negative slope.

A3288. In response, the examiner cancelled claims containing this language, noting:

> It is well-known in the art that the shock absorber force at the wheel is related to the shock absorber force multiplied by the leverage ratio. Accordingly, any graph can be broken down into three equal parts and, because lines on a graph must have a positive, negative, or zero slope, the Miyakoshi reads on each of the selected groups provided for in claims 98, 106 and 114.

A3302. In response to the examiner's rejections, Split Pivot stated:

> Claims 92-96, 98-102, 104, 106, 107, 109-112, 114-117 and 119 were rejected under 35 U.S.C. § 102(b) as allegedly anticipated by United States Patent No. 4,497,506 to Miyakoshi ("Miyakoshi"). *Applicant respectfully traverses the rejections*. *Without acquiescing in the rejections or the grounds therefor, and solely to expedite prosecution, claims 95, 101, 112 and 117 have been canceled* with entry of this Amendment and claims 92, 94, 96, 98, 100, 102, 104, 106, 107, 109, 111, 114, 116 and 119 have been amended. *Applicant submits that Miyakoshi does not teach or suggest a suspension system as described* in claims 92-96, 98-102, 104, 106, 107, 109-112, 114-117 and 119, or as described in any one of new claims 120-192. *Applicant therefore requests that the rejections be withdrawn*.

A3331 (emphasis added). Nowhere did Split Pivot expressly disclaim a curve that includes a zero slope in the first or last thirds of the curve. As indicated, the examiner allowed embodiments described in the specification that provide for "a positive slope, zero slope, and or a negative slope" in the beginning and end thirds of the leverage ratio curve. A130.

While the District Court claimed that "Split Pivot conceded by amendment to limit its claims to only those suspension systems with leverage ratio curves that have *only* a positive or negative slope in the first and last thirds," this conclusion is not supported by the prosecution history or the plain language of the '301 Patent. Instead of giving effect to the plain language of the '301 Patent, the District Court eviscerated it with a construction of "has a negative or positive slope" that excludes preferred embodiments. This Court should reverse the District Court's

construction, and construe "has a negative or positive slope" to mean "has a negative and/or a positive slope, and may include a zero slope."

II. WITH PROPER CLAIM CONSTRUCTION, TREK'S ACCUSED BICYCLES INFRINGE THE ASSERTED CLAIMS.

Under Split Pivot's proposed construction of the disputed claim terms, Trek's Accused Bicycles literally infringe all asserted claims of the '212 and '301 Patents. However, even if the Court does not vacate the District Court's erroneous construction of the disputed claim terms, genuine issues of material fact exist with regard to infringement under the doctrine of equivalents.

A. The District Court's Judgment of Non-Infringement Should Be Vacated.

The District Court's judgment of non-infringement of the '212 Patent as to Trek's ABP models hinged entirely on its construction of the Shock Absorber Markush term. A60-62. If this Court vacates the District Court's construction of the Shock Absorber Markush term and adopts Split Pivot's, it must also vacate the District Court's judgment of non-infringement with respect to Trek's ABP model bicycles. A2109-2113; A2127-2133; A2515-2547; A3764-3766.

The District Court's judgment of non-infringement of the '212 Patent as to Trek's Full Floater models also hinged on its construction of the Mounting Markush term. Therefore, if this Court vacates the District Court's construction of the Shock Absorber *and* Mounting Markush terms and adopts Split Pivot's, it must

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also vacate the District Court's judgment of non-infringement with respect to Trek's Full Floater model bicycles. A2109-2127; A2515-2547; A3774-3775.

The District Court's judgment of non-infringement of the '301 Patent as to all of Trek's Accused Bicycles hinged on its construction of the Shock Absorber Markush term and the limitations "change in slope value" and "has a negative or positive slope." A66-69. If the Court vacates the District Court's construction of the Shock Absorber Markush term and the limitations "change in slope value" and "has a negative or positive slope," and adopts Split Pivot's constructions, then the Court must vacate the District Court's finding of non-infringement with respect to Trek's Accused Bicycles. A2133-2163; A3774-3775; A3788-3790.

B. <u>The District Court's Judgment of Non-Infringement Under the Doctrine of Equivalents Should Be Vacated.</u>

If this Court does not reverse the District Court's incorrect construction of the Mounting Markush term, but reverses the District Court's incorrect construction of the Shock Absorber Markush term, it should vacate the District Court's judgment of non-infringement under the doctrine of equivalents with regard to the '212 Patent and Trek's Full Floater equipped models. The District Court incorrectly held that Trek's Full Floater equipped models did not infringe under the doctrine of equivalents even though genuine issues of material fact existed.

"A finding of infringement under the doctrine of equivalents requires a showing that the difference between the claimed invention and the accused product was insubstantial." *Crown Packaging Tech., Inc. v. Rexam Bev. Can Co.*, 559 F.3d 1308, 1312 (Fed. Cir. 2009). "Infringement under the doctrine of equivalents 'does not require complete identity for every purpose and in every respect,' … but does require substantial identity of function, means, and result." *Lear Siegler, Inc. v. Sealy Mattress Co.*, 873 F.2d 1422, 1425 (Fed. Cir. 1989). "Whether the substitute element (1) has substantially the same function as the recited element, (2) achieves that function in substantially the same way, and (3) achieves substantially the same result are questions of fact." *Charles Mach. Works, Inc. v. Vermeer Mfg. Co.*, 723 F.3d 1376, 1380 (Fed. Cir. 2013). When analyzing infringement under the doctrine of equivalents, courts must "resolve any reasonable factual inferences in favor of the nonmoving party." *Crown Packaging Tech., Inc.*, 559 F.3d at 1315.

With respect to the Mounting Markush term, the District Court did not understand Split Pivot's evidence of infringement under the doctrine of equivalents. The District Court alleged that Split Pivot failed to propose "any facts suggesting that Trek's Full Floater bicycles, with shock absorbers mounted to two links, achieve substantially the same results in substantially the same way as the suspension system of the claimed invention." A63. It therefore ignored Split

Pivot's expert's conclusion, using the 2013 Trek Fuel EX as an example, that it is easily possible to achieve the same suspension characteristics of Trek's Full Floater configuration with a non-floating arrangement, such as that defined by the District Court in the '212 Patent. A2540-2541.

Split Pivot's expert showed that Trek's Full Floater models performed substantially the same function, in substantially the same way, to achieve substantially the same result as a non-floating arrangement shown in the '212 Patent. A2117-2122; A2402-2411; A2541. Split Pivot demonstrated that the Full Floater bicycles were indistinguishable from a performance standpoint from non-floating shock arrangements, and that a floating arrangement had more to do with marketing considerations than performance. A2117. Therefore, Split Pivot showed that the differences between the non-floating embodiments claimed in the '212 Patent and Trek's Full Floater Bicycles are insubstantial, and the District Court failed to resolve this factual issue in favor of Split Pivot. *Crown Packaging Tech., Inc.*, 559 F.3d at 1315.

III. THE COURT SHOULD REVERSE THE DISTRICT COURT'S FINDING OF NO WILLFULL INFRINGEMENT.

Once this Court reverses the District Court's finding of non-infringement, either literally or under the doctrine of equivalents, it must also vacate the finding of no willful infringement. *See generally* A3822-3836; A4331-4340. To establish willful infringement, Split Pivot must show by clear and convincing evidence that

Trek acted "despite an objectively high likelihood that its actions constituted infringement of a valid patent" and "that this objectively-defined risk (determined by the record developed in the infringement proceeding) was either known or so obvious that it should have been known" to Trek. *In re Seagate Tech, LLC,* 497 F.3d 1360, 1371 (Fed. Cir. 2007). The objective test focuses on facts and circumstances available to Trek at the time it commenced selling infringing bicycles. *See i4i Ltd. P 'ship v. Microsoft Corp.,* 670 F. Supp. 2d 568, 581 (E.D. Tex. 2009), *aff'd,* 589 F.3d 1246 (Fed. Cir. 2009). A proper objective recklessness analysis focuses on whether, "given the facts and circumstances prior to [the accused's] infringing actions, a reasonable person would have appreciated a high likelihood that acting would infringe a valid patent." *See id.* at 582; *see also In re Seagate Tech, LLC,* 497 F.3d at 1374.

Trek did not present any evidence showing it had any non-infringement or invalidity defenses at the time it began infringing the '212 Patent on May 18, 2010, or the '301 Patent on August 23, 2011. A3826. To the contrary, [redacted] *Id.*; A4470-4477.

Trek first learned that Weagle had applied for a patent on the Split Pivot suspension when it received the presentation from him on March 20, and learned

further details about the invention in a meeting on April 26, 2007. A3827. After its attempt to lowball Split Pivot with an offer for the Patents failed, Gonzalez told Weagle [redacted] A517-519; A3827. Split Pivot later sent copies of its then-pending patent applications to Trek's general counsel on January 26, 2009, and Trek actively monitored the prosecution of the Patents. A3827; A4229-4230. In light of these facts, there was an objectively high likelihood that Trek's actions constituted infringement of a valid patent.

Trek also did not rely on any credible non-infringement or invalidity defenses at the time it began infringing the Patents. *See* A3830-3834. Indeed, while prosecuting its own patent applications, which covered essentially the same subject matter as the Patents, Trek ignored the same invalidity arguments it later raised before the District Court. *Id*. Trek's failure to take these allegedly invalidating prior art references into account with respect to its own patents demonstrate that it could not credibly have believed it possessed a valid invalidity defense. *Id*.

Trek knowingly disregarded the objective risk that its Accused Bicycles infringed the Patents. A3834-3836. After Trek learned of the Split Pivot design and the conflict with its ABP design, it actively sought a meeting with Weagle in order to gain additional intelligence about his design. *Id*. Trek then proceeded to

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introduce ABP three weeks after Split Pivot introduced its revolutionary invention to the world, and continued to devise ways to undermine Split Pivot in the marketplace. *Id.*; A4248-4259

Given these facts, clear and convincing evidence shows Trek willfully infringed the Split Pivot Patents. Trek is not entitled to summary judgment of no willful infringement.

CONCLUSION

For the foregoing reasons, the District Court's judgment should be reversed and this action remanded for further proceedings.

Dated: April 22, 2014.

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ADDENDUM

ADDEDNUM TABLE OF CONTENTS

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WISCONSIN

SPLIT PIVOT, INC.,

Plaintiff, OPINION & ORDER

v.

12-cv-639-wmc

TREK BICYCLE CORPORATION,

Defendant.

In this patent lawsuit, plaintiff Split Pivot, Inc. alleges that defendant Trek Bicycle Corporation ("Trek") infringes claims in two of its patents, both of which involve suspension systems for bicycles. As is common in patent cases, the parties have filed cross-motions for summary judgment. Split Pivot seeks summary judgment of infringement on claim 22 of U.S. Patent No. 7,717,212 ("the '212 patent"). Trek seeks summary judgment of non-infringement on *all* asserted claims of the '212 patent, as well as summary judgment for invalidity based on inadequate written descriptions in various claims of the '212 patent. Trek also seeks summary judgment of non-infringement and invalidity due to anticipation on all asserted claims of Split Pivot's other patent, U.S. Patent No. 8,002,301 ("the '301 patent"). As part of these motions, the parties also ask the court to construe various terms shared by the patents in suit. For the reasons set forth below, the court will deny Split Pivot's motion for summary judgment of infringement and will grant Trek's motion for summary judgment of non-infringement of both patents.

BASIC ALLEGATIONS OF FACT[1]

I. The Parties

Plaintiff Split Pivot, Inc. is a Massachusetts corporation engaged in the business of holding patents. Its owner and sole employee is David Weagle, the putative inventor of the '212 patent and the '301 patent.

Defendant Trek Bicycle Corporation is a privately-held Wisconsin company with its principle place of business in Waterloo, Wisconsin. Trek designs, manufactures and sells bicycles, including road bikes, mountain bikes, town bikes and specialty bikes. Within the mountain bike category, Trek designs, manufactures and sells mountain bikes with and without rear suspensions.

II. The Technology and Patents in Suit

The technology at issue in the patents in suit involves rear suspension systems for vehicles generally, though the patents' specifications depict only rear suspension systems for bicycles. Bicycles without rear suspension systems usually consist of a frame made up of tubes that are welded or otherwise integrally connected to one another. A bicycle *with* a rear suspension system uses instead a set of links that are pivotally connected to one another and that support the rear wheel. Those links are generally connected to some form of shock absorber. The end result of using a rear suspension system on a bicycle is that the rear wheel is capable of moving up and down as it encounters rough terrain, increasing rider comfort and control.

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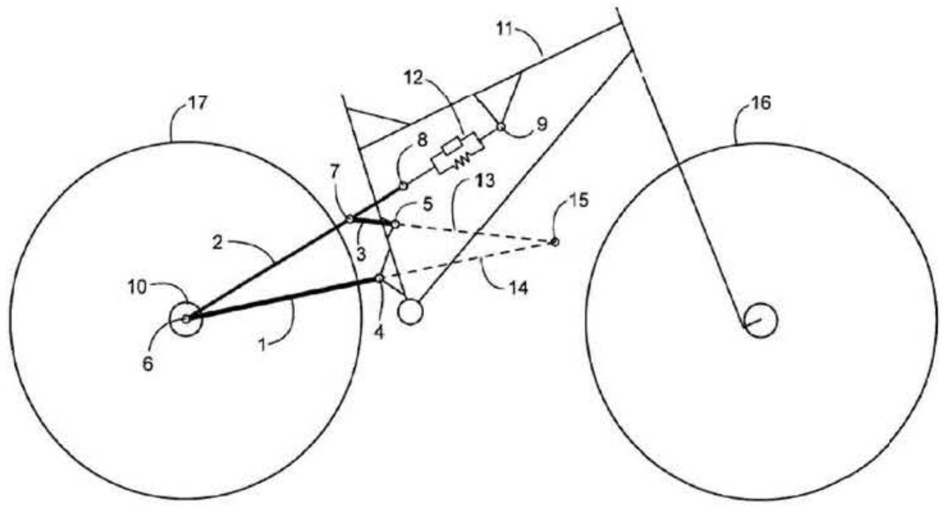
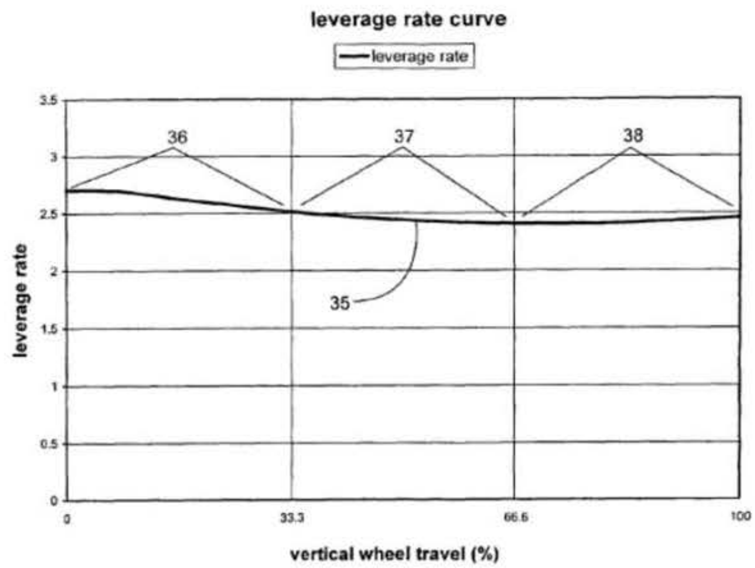
[1] The court lays out only the most basic facts here. More specific facts will be introduced and discussed where relevant to the specific issues in this case.



(Pictured: Figure 1 of the '212 patent, which features a bicycle design with a rear suspension system. The shock absorber is located at 12; the links are located at 1, 2 and 3.)

The distance a rear wheel can move up and down in a bicycle with shock absorbers is known as the "compressible wheel suspension travel distance," with the beginning travel point being where the suspension is completely uncompressed, such that it cannot extend further, and the end travel point where the suspension is completely compressed, such that it cannot compress further. At the beginning travel point, the shock absorber is necessarily in the state of least compression, so it is relatively easy to compress the suspension. Measuring the travel distances of both the wheel and the shock absorber allows for calculation of the "leverage ratio" (also called "leverage rate"), which is the ratio of the compressive wheel travel change to the measured length change in the shock absorber over the same wheel travel distance. As the suspended wheel moves compressively -- that is, as it moves closer to the end travel point -- the shock absorber force at the wheel changes in relation to shock absorber force multiplied by that leverage ratio.

The leverage ratio does not necessarily remain the same throughout the wheel travel distance. A "leverage ratio curve," also known as a "leverage rate curve," is a graphical representation of leverage ratio versus wheel travel, plotted on a Cartesian graph, where the leverage ratio (as defined above) is shown on the Y axis, and vertical wheel travel is shown on the X axis:



(Pictured: Figure 18 of the '301 patent, showing the leverage ratio curve of certain embodiments of the invented suspension system. The curve itself is labeled 35.)

To graph a leverage ratio curve, as the wheel is compressed, incremental vertical compression distance measurements of the wheel are taken. At each one of those points, the length of the shock absorber is also measured. The leverage ratio can then be calculated at each point in the suspension system's compression and graphed as shown above.

Leverage ratios can be manipulated to achieve a desired force output at the wheel. This is because shock absorber length, which serves as the denominator of the leverage ratio, can be changed by the movement of wheel, brake and/or control links as the suspension

compresses. Thus, while every suspension system inherently has a leverage ratio -- and therefore inherently has a leverage ratio curve – different suspension systems may be designed to have particular leverage ratio curves.

While suspension systems increase rider comfort and control over rough terrain, a side effect is that acceleration or deceleration forces may cause a suspension system to react in unwanted ways. According to the patents, systems exist to reduce unwanted suspension movement during acceleration or deceleration, but those systems are both complex and correspondingly expensive. Less expensive systems, in contrast, are more cost-effective but do not allow for the separation of acceleration forces under powered acceleration and braking. Weagle claims "suspension systems that can provide separated acceleration and deceleration responses while remaining cost effective to produce." ('212 patent, 1:48-50; '301 patent, 1:52-54.)[2]

A. The '212 Patent

The application that resulted in the '212 patent was filed on August 25, 2006, and the '212 patent itself issued on May 18, 2010. The abstract of the '212 patent states that the invention relates to "suspension systems comprising, in certain embodiments, a pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by placement of an instant force center, and so that acceleration forces can be controlled by a swinging wheel link."

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[2] For ease of citation, and in keeping with general practice, the number preceding the colon will denote the patent's column number, while the number following the colon refers to the line number or numbers cited.

Split Pivot asserts infringement of claims 1, 3, 4, 5, 6, 12, 14, 21, 22, 24, 25, 26, 32, 34, 41, 42, 43, 44 and 64 of the '212 patent. Claims 1, 22 and 43 are independent; the other claims at issue depend from those claims.

Claim 1 provides:

> A suspension system for a vehicle comprising
>
> a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link and a shock absorber,
>
> wherein said wheel link floating pivot is concentric with said wheel rotation axis;
>
> wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link;
>
> wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid;
>
> and wherein force that compresses said shock absorber is transmitted through said brake link;
>
> and wherein said brake link passes on two sides of a frame member.

('212 patent, 19:64-20:8.)

Claim 22 provides:

> A suspension system for a vehicle comprising
>
> a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link, a control link and a shock absorber,
>
> wherein said wheel link floating pivot is concentric with said wheel rotation axis
>
> and where said wheel link and said control link are arranged so that an instant center of the suspension system is located below the control link when the suspension is uncompressed and the vehicle is on even ground;

> wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link;
>
> wherein force that compresses said shock absorber is transmitted through said brake link;
>
> wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid;
>
> and wherein said suspension system further comprises a wheel link fixed pivot, a control link floating pivot and a control link fixed pivot.

('212 patent, 21:22-38.)

Claim 43 provides:

> A suspension system for a vehicle comprising
>
> a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link, and a shock absorber,
>
> wherein said wheel link floating pivot is concentric with said wheel rotation axis;
>
> wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid;
>
> and wherein force is transmitted to said shock absorber through said brake link;
>
> wherein said brake link passes on two sides of a frame member.

('212 patent, 22:54-62.)

Split Pivot has moved for summary judgment of infringement on claim 22 of the '212 patent. It alleges that Trek's Fuel EX and Superfly 100 products infringe this claim literally and under the doctrine of equivalents. (*See* dkt. #114.)

Trek has cross-moved for summary judgment of non-infringement on all the independent claims of the '212 patent (which necessarily includes the dependent claims as

well, since a dependent claim is "construed to incorporate by reference all the limitations of the claim to which it refers," 35 U.S.C. § 112). Trek also argues that it is entitled to summary judgment based on inadequate written descriptions under 35 U.S.C. § 112 in independent claims 1 and 22, as well as those that are dependent on them.

B. The '301 Patent

The '301 patent is a continuation in part of the '212 patent.[3] Filed on August 23, 2007, and issued on August 23, 2011, the '301 patent claims certain suspension systems for vehicles; its abstract reads that the "invention relates to suspension systems comprising, in certain embodiments, a pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by placement of an instant force center, and so that acceleration forces can be controlled by a swinging wheel link." ('301 patent, abstract.)

Split Pivot asserts infringement of claims 29, 30, 31, 37, 38, 39 and 43 of the '301 patent. Claims 29 and 37 are independent; the other claims depend from those two claims.

Claim 29 reads:

> A suspension system for a vehicle comprising
>
> a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a brake link, a control link floating pivot, a control link fixed pivot, and a shock absorber;
>
> wherein the distance between said wheel link floating pivot and control link floating pivot is greater than the distance between said control link fixed pivot and control link floating pivot;
>
> wherein said wheel link is pivotally connected to said brake link;

[3] A "continuation in part" application "is a continuing application containing a portion or all of the disclosure of an earlier application together with added matter not present in that earlier application." *Transco Prods. Inc. v. Performance Contracting, Inc.*, 38 F.3d 551, 555 (Fed. Cir. 1994) (citing *The Manual of Patent Examining Procedure*, § 201.08 (1988)).

wherein said brake link is pivotally connected to said control link;

wherein said wheel link floating pivot is concentric with said wheel rotation axis;

wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid;

wherein force is transmitted to said shock absorber through an element selected from the group consisting of the brake link, the control link, a wheel link fixed pivot, the control link floating pivot and the control link fixed pivot;

wherein said suspension system further comprises a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place;

and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning 1/3 (third) and in the end 1/3 (third), and a change in slope value in the middle 1/3 (third).

('301 patent, 36:60-37:19.)

Claim 37 reads:

A suspension system for a vehicle comprising

a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a removable pivot axle;

wherein said wheel link floating pivot is concentric with said wheel rotation axis;

wherein said brake link is pivotally connected to said control link;

wherein said removable pivot axle has a feature for positioning a rear hub in relation to said wheel rotation axis;

> wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt;
>
> wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid;
>
> wherein force is transmitted to said shock absorber through said brake link;
>
> and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning 1/3 (third) and in the end 1/3 (third), and a change in slope value in the middle 1/3 (third).

('301 patent, 37:56-38:7.)

Trek also seeks summary judgment of non-infringement and invalidity due to anticipation on all asserted claims of the '301 patent.

III. Trek's Allegedly Infringing Products

Trek markets and sells a wide variety of bicycles with rear suspension systems. The allegedly infringing products fall into two basic categories: (1) those with what Trek calls "Active Brake Pivot" ("ABP"); and (2) those with both ABP and what Trek calls "Full Floater."

ABP refers to the ability of the rear suspension to remain active while the brake is applied. ABP bicycles include, among other features, some pivotal connection that is concentric with the rear wheel rotation axis. Bicycles with ABP only have a shock absorber that is mounted parallel to the top tube and connected on one side to the frame. They are sometimes called "swing link" bikes, which refers to the short link hanging from the top

tube of the frame. ABP bicycles include Trek's Superfly 100, HiFi, Rumblefish and Roscoe. The 2010 Superfly 100 is pictured below:

Bicycles including ABP *and* Full Floater include Trek's Fuel EX, Scratch (including Scratch Air), Top Fuel, Session, Slash, Lush and Remedy. "Full Floater" is so named because a bicycle including Full Floater has a generally vertically mounted shock absorber connected to two moving links; the shock absorber "floats" between the two links instead of being fixed to the frame on one side. The 2010 Fuel EX 9.9 is pictured below:

PROCEDURAL MATTER

Split Pivot asks the court to strike as untimely (1) Trek's construction of "wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid" ("the '212 Shock Absorber Element"); and (2) Trek's related contention that this element is a missing limitation from its accused bicycles. Trek argues its disclosure *was* timely and that Split Pivot has not been prejudiced in any event.

The current dispute began when Split Pivot served Trek with untimely supplemental claim charts on January 4 and January 24, 2013. The January 24 charts were served in response to Trek's production of previously undisclosed drawings of some of its accused bicycles on December 5 and 10, 2012, and added assertions of infringement of three claims upon which Split Pivot had not previously relied: claims 43, 44 and 64 of the '212 patent.

Trek moved to strike the January 24 supplemental claim chart on February 1, 2013. (Dkt. #46.) On May 2, 2013, the court denied the motion, finding that while Split Pivot's supplement was untimely, Split Pivot had acted with reasonable diligence in responding within a month and a half to Trek's newly-disclosed drawings; that the supplement appeared to be a direct response to these newly-disclosed drawings; and that the new contentions were unlikely to prejudice Trek materially. (Opinion & Order (dkt. #90) 5-6.) To ameliorate any arguable prejudice, the court also gave Trek 28 days to supplement its own infringement and invalidity contentions, "provided any newly asserted disclosures respond[ed] directly to the supplemental infringement claim charts served on January 24, 2013." (*Id.* at 8.)

On May 30, 2013, within the court-imposed 28 day deadline, Trek responded to Split Pivot's supplemental infringement contentions. The response included, among other

things asserted, a missing limitation not previously disclosed: the '212 Shock Absorber Element. On June 3, 2013, Trek served a supplemental claim construction as to this limitation.

It is undisputed that the '212 Shock Absorber Element appears in independent claim 43, and accordingly in claims 44 and 64, which depend from it. To that extent, it does directly respond to Split Pivot's newly asserted claims. Split Pivot points out that the Shock Absorber Element *also* appears in independent claim 1 ('212 patent, 20:3-5) and independent claim 22 ('212 patent, 21:34-36), as well as in all claims that depend from them -- in essence, in every claim of the '212 patent that Trek has allegedly infringed. (*See* Def.'s Br. in Support of Summ. J. Exh. A (dkt. #133-1).) The allegedly infringed claims of the '301 patent -- claims 29 and 37, and certain claims that depend from them -- also include a version of the Shock Absorber Element ("the '301 Shock Absorber Element"), which simply adds "a damper" to the enumerated list of possible shock absorbers.[4] (*See* '301 patent, 37:3-6; 37:67-38:2.)

At this point, the court will not preclude Trek from arguing for non-infringement based on the Shock Absorber Element. While Trek could have asserted non-infringement based on this element earlier, the court recognized in allowing Split Pivot's untimely assertions of infringement that Trek might choose to "rethink its strategy," just as apparently had Split Pivot. (Opinion & Order (dkt. #90) 7.) Moreover, the Shock Absorber Element *is* directly responsive to the newly asserted claims, insofar as it appears in

[4] Trek has moved for non-infringement of the Shock Absorber Element in both patents based on shared claim language that indicates a Markush group, discussed in more detail below. Thus, while the Shock Absorber Element is not identical between the '212 patent and the '301 patent, Trek's non-infringement argument is.

all three of them. Finally, the court is not inclined to disallow one of Trek's principal defenses when Split Pivot has been aware of that defense since May, choosing (likely tactically) to lie in the weeds until filing a motion for summary judgment in August. If Split Pivot was prejudiced -- which it does not even argue – the proper time to bring it to the court's attention was not at summary judgment but at the time of the allegedly prejudicial event. Split Pivot's motion to strike is, therefore, denied.

OPINION

I. Overview of Issues

Analysis of patent infringement is a two-step process: "first, the scope of the claims are determined as a matter of law, and second, the properly construed claims are compared to the allegedly infringing device to determine, as a matter of fact, whether all of the limitations of at least one claim are present, either literally or by a substantial equivalent, in the accused device." *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1323 (Fed. Cir. 2002). Invalidity of the patent in suit serves as a defense to infringement. 35 U.S.C. § 282.

II. Claims Construction

The court begins its claim construction analysis, "as always, with the words of the claim." *Teleflex, Inc.* 299 F.3d at 1324. The claims "define the scope of the right to exclude; the claim construction inquiry, therefore, begins and ends in all cases with the actual words of the claim." *Id.* (quoting *Renishaw PLC v. Marposs Societa per Azioni*, 158 F.3d 1243, 1248 (Fed. Cir. 1998)). In order to interpret the words of the claims, courts look to "the intrinsic evidence of record, including the written description, the drawings, and the prosecution

history, if in evidence." *Id.* (citing *Interactive Gift Express, Inc. v. Compuserve, Inc.*, 256 F.3d 1323, 1331 (Fed. Cir. 2001)). Generally speaking, "all terms in a patent claim are to be given their plain, ordinary and accustomed meaning to one of ordinary skill in the relevant art." *Rexnord Corp. v. Laitram Corp.*, 274 F.3d 1336, 1342 (Fed. Cir. 2001). There are exceptions to this general rule, however. For example, patent law does "permit[] the patentee to choose to be his or her own lexicographer by clearly setting forth an explicit definition for a claim term that could differ in scope from that which would be afforded by its ordinary meaning." *Id.*

Once the court has ascertained the plain meaning of a term to the person of ordinary skill in the art, "the next step is to examine the written description and the drawings to confirm that the patentee's use of the disputed terms is consistent with the meaning given to it by the court." *Id.* In this step, the court seeks to determine whether the patentee has expressed a different meaning for the language; whether the preferred embodiment is consistent with the court's initial interpretation; and whether the inventor has explicitly disclaimed subject matter or limited the scope of the claims. *Id.* at 1342-43. Although claims must be construed in light of the specification for these reasons, *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 979 (Fed. Cir. 1995) (en banc), "limitations from the specification are not to be read into the claims," *Golight, Inc. v. Wal-Mart Stores, Inc.*, 355 F.3d 1327, 1331 (Fed. Cir. 2004). Regardless, the specification is the "single best guide to the meaning of a disputed term." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1315 (Fed. Cir. 2005).

"After examining the written description and the drawings, the same confirmatory measure must be taken with the prosecution history." *Rexnord Corp.*, 274 F.3d at 1343.

This is because "a patentee may limit the meaning of a claim term by making a clear and unmistakable disavowal of scope during prosecution." *Computer Docking Station Corp. v. Dell, Inc.*, 519 F.3d 1366, 1374 (Fed. Cir. 2008) (quoting *Purdue Pharma L.P. v. Endo Pharms., Inc.*, 438 F.3d 1123, 1136 (Fed. Cir. 2006)); *see also Cross Med. Prods., Inc. v. Medtronic Sofamor Danek, Inc.*, 480 F.3d 1335, 1341 (Fed. Cir. 2007) ("Prosecution history estoppel prevents a patentee from recapturing under the doctrine of equivalents subject matter surrendered during prosecution to obtain a patent."). Such a limitation might arise, for instance, if the patentee "clearly characteriz[es] the invention in a way to try to overcome rejections based on prior art." *Computer Docking Station Corp.*, 519 F.3d at 1374. Even if the patent prosecutor does not rely on the patentee's statements in subsequently approving a patent, the patentee may nevertheless "be held to what he declares during the prosecution of his patent." *Springs Window Fashions LP v. Novo Indus., L.P.*, 323 F.3d 989, 995 (Fed. Cir. 2003); *see also Desper Prods., Inc. v. QSound Labs, Inc.*, 157 F.3d 1325, 1336 (Fed. Cir. 1998) ("That the prosecution shifted to a different focus does not blunt the impact of those remarks made to overcome the prior rejection.").

District courts may also rely on extrinsic evidence in claim construction, such as expert and inventor testimony, dictionaries and learned treatises. *Phillips*, 415 F.3d at 1317. Extrinsic evidence "can shed useful light on the relevant art," but it is "less significant than the intrinsic record in determining the legally operative meaning of claim language." *Id.* (quoting *C.R. Bard, Inc. v. U.S. Surgical Corp.*, 388 F.3d 858, 862 (Fed. Cir. 2004)). "In sum, extrinsic evidence may be useful to the court, but it is unlikely to result in a reliable interpretation of patent claim scope unless considered in the context of the intrinsic evidence." *Id.* at 1319.

A. Wheel Link Floating Pivot

The parties agree that the term "wheel link floating pivot" is one for which Weagle served as his own lexicographer, rather than a term of art to which the court may ascribe an ordinary and customary meaning. "[T]erms coined by the inventor are best understood by reference to the specification," *3M Innovative Properties Co. v. Tredegar Corp.*, 725 F.3d 1315, 1321 (Fed. Cir. 2013), though the rule that "limitations discussed in the specification may not be read into the claims" remains in effect." *Id.* The parties offer the following constructions of "wheel link floating pivot":

Split Pivot	Trek
"a pivot that changes its vertical and horizontal position relative to the frame of the vehicle when the rear suspension is compressed, is concentric with a rear wheel rotation axis of the vehicle, and pivotally connects to the brake link"	"a pivot axle connected to the wheel link that allows a link to rotate about the pivot axle and changes its position relative to a frame member when the suspension is compressed"

Split Pivot asserts that its construction is correct because it incorporates language "nearly verbatim" from the specification. (Pl.'s Br. for Summ. J. (dkt. #114) 8.) First, the specification notes that "a floating pivot changes its position relative to the frame when the suspension is compressed." ('212 patent, 4:6-8.) Additionally, the specification provides that a wheel link floating pivot "is concentric with a wheel rotation axis of the vehicle, preferably the wheel rotation axis of a driven wheel, a rear wheel, a front wheel, or a suspended wheel of a vehicle." ('212 patent, 11:15-19.) Finally, the specification indicates that the "wheel link floating pivot pivotally connects the wheel link to the brake link." ('212 patent, 4:65-66.) These portions of the specification, Split Pivot asserts, clearly

demonstrate how Weagle, as the inventor, intended to define the term "wheel link floating pivot," and so its construction makes use of those descriptors while adding additional detail to correspond to this particular invention (i.e., the "vertical and horizontal" nature of the movement of the floating pivot, and the focus on the "rear" suspension and wheel).

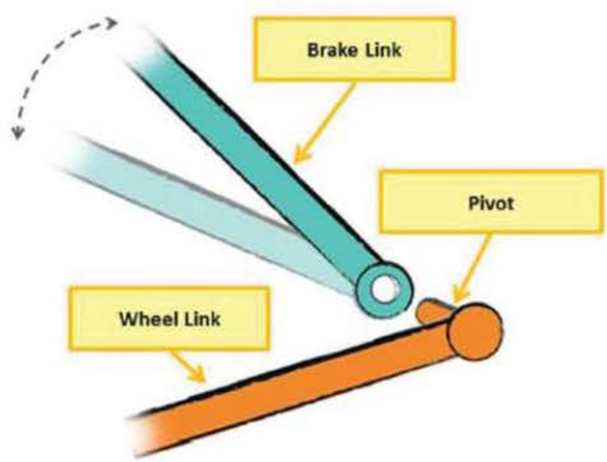
Trek includes the general language from the specification defining "floating pivot" in its construction. Trek also asks the court to construe "wheel link floating pivot" as requiring a pivot *axle*. In support, Trek argues that a person of ordinary skill in the art would understand the term "pivot" to require a pivot axle, bolstering this argument with citations to multiple dictionaries. (Def.'s Resp. (dkt. #149) 7 (citing to definitions of a pivot as a "short shaft or pin," "an axle on which a wheel turns," "a fixed pin or short axis," etc.).) Additionally, Trek construes "wheel link floating pivot" as being "connected to the wheel link." As support for that interpretation, Trek points to a portion of the specification, which states that "[p]ivots of a suspension system of the invention are named after a component that connects with the pivot." ('212 patent, 4:2-4.) By this logic, then, a "wheel link floating pivot" *must* be connected to the wheel link.

Taking the last argument first, the court agrees with Trek insofar as a floating pivot without *any* connection to the wheel link could not be a "wheel link floating pivot." Nothing in the patent, however, suggests that a wheel link floating pivot may not have multiple connections; indeed, even the sentence that Trek identifies states that pivots are named after *a* component that connects with them, which leaves open the possibility for a pivot to be connected to multiple components but named after just one. In addition, the specification unambiguously contemplates a wheel link floating pivot serving as the "connection point" between the wheel link *and* the brake link. In describing the preferred

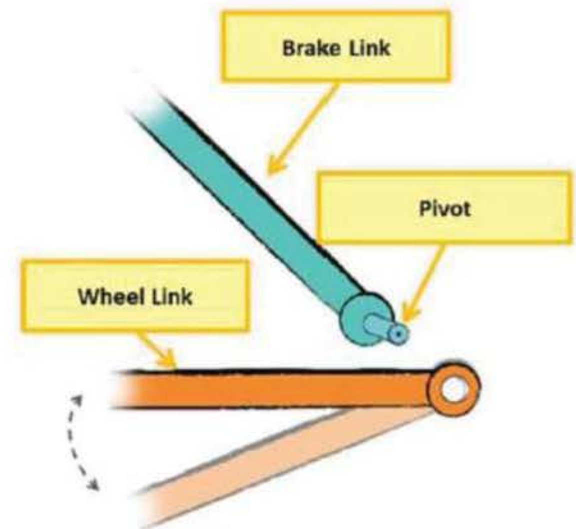
embodiments of the invention, for example, the specification states that "[t]he wheel floating link pivot (*sic*) 6 pivotally connects the wheel link 1 to a brake link 2." (*See* '212 patent, 4:65-67 (figure 1); 5:59-61 (figure 2); 7:14-15 (figure 5).) Thus, the context of the specification makes clear that a wheel link floating pivot serves as a "connecting point" between the wheel link *and* the brake link.

Rather than dispute this fact, Trek takes a different tack by arguing that a pivot can only be "*connected*" to a component when it is permanently *fastened* to that component, meaning that a link which merely "rotates about" the pivot is *not* connected to it. In essence, without disputing that the wheel link floating pivot is pivotally connected to the wheel link and brake link, Trek argues that within this connection, the pivot itself may *only* be fastened to the wheel link.

Thus, Trek's construction, which states that the wheel link floating pivot is "connected to the wheel link," would support only arrangements in which the pivot is fastened to the wheel link:



It would exclude any arrangement in which the pivot is fastened to the brake link:



The court sees no reason, and Trek offers none, to limit an interpretation of "connected" to mean "permanently" or "immovably fastened." Moreover, the detailed description of the invention contradicts Trek's proposed interpretation: "[a] *wheel link*, in certain embodiments, is connected to a *wheel link floating pivot* and/or a wheel link fixed pivot" ('212 patent, 8:37-39) (emphasis added), *and* "[a] *brake link*, in certain embodiments, is connected to a *wheel link floating pivot*, a control link floating pivot and/or a first shock pivot" ('212 patent, 9:10-12) (emphasis added). Thus, Weagle described a wheel link *and* a brake link as "connected to" a wheel link floating pivot. ('212 patent, 8:37-38; 9:10-11.) Nowhere did Weagle suggest that the nature of these connections need vary between the wheel link and the brake link. Rather, he used exactly the same term to describe the wheel link floating pivot's relationship to the wheel link as he did to describe its relationship to the brake link. While the *overall* connection of the wheel link to the brake link must be pivotal, the patent simply does not evince an intention to limit the definition of "wheel link

floating pivot" to arrangements wherein the wheel link floating pivot is immovably fastened to the wheel link, with the brake link turning around it.

Trek points out that the drawings of Figures 7 and 8 show only embodiments in which the wheel link floating pivot is fastened to the wheel link, with the brake link able to turn around it.[5] (*See* Def.'s Br. for Summ. J. (dkt. #125) 16-17.) Figure 7 shows "a three-dimensional cutaway view of a wheel link floating pivot 6 as shown in FIG. 2, 4, 5 and FIG. 6." ('212 patent, 7:63-64.) Turning to the description of Figure 5, Trek is correct that the wheel link floating pivot of that particular embodiment "comprises a pair of clevis[es] that . . . are structural components of wheel link 1, and a pair of hitches to be received by the clevises, where the hitches are structural components of the brake link 2." ('212 patent, 7:16-19.) This would allow the brake link to turn, while the wheel link remains stationary.

While Trek accurately describes the construction of the wheel link floating pivot of Figures 7 and 8, "limitations from parts of the written description, such as the details of the preferred embodiment, cannot be read into the claims absent a clear intention by the patentee to do so." *MySpace, Inc. v. GraphOn Corp.*, 672 F.3d 1250, 1256 (Fed. Cir. 2012). In light of the detailed description, which expressly contemplates that a wheel link floating pivot may be "connected" to a wheel link in certain embodiments and a brake link in certain embodiments, the court finds no "clear intention" to limit the definition to the embodiment of Figures 7 and 8, even if it *did* find that the word "connect" mandated an *immovable* connection (which it does not).

The court likewise rejects Trek's contention that the court must construe the word "pivot" to mean "pivot axle." As a preliminary matter, the court declines to isolate and

[5] Figure 8 does not appear in the '212 patent, but does appear in the '301 patent.

construe a single word to limit a claim, when that word is indisputably part of a term for which Weagle served as his own lexicographer. Additionally, the specification never hints at an intent by Weagle to limit a wheel link floating pivot to a single pivot *axle*. Rather, the detailed description of Figure 7 indicates that "[c]ertain embodiments of the wheel link floating pivot 6 can comprise a pivot bearing 20." ('212 patent, 8:4-5.) While the description goes on to note that "[a] pivot axle 21 acts as a bearing surface for the pivot bearing 20" ('212 patent, 8:14-15), this simply states that certain embodiments of the wheel link floating pivot may *contain* a pivot axle, not that the pivot itself must be a pivot axle and nothing else.[6]

Despite rejecting Trek's proposed construction, the court also declines to adopt Split Pivot's construction in two respects. First, Split Pivot asks that the court construe "wheel link floating pivot" to include the requirement that it be "concentric with a rear wheel rotation axis of the vehicle." As Trek points out, every independent claim of the '212 patent includes not only the phrase "wheel link floating pivot" but also a separate requirement that "said wheel link floating pivot is concentric with said wheel rotation axis." (*See, e.g.*, '212 patent, 19:64-20:1.) To hold that the wheel link floating pivot must *inherently* be concentric with the wheel rotation axis would render this element of the claims meaningless. Claims construction standards do not generally allow for such a result. *See, e.g.*, *Merck & Co., Inc. v. Teva Pharm. USA, Inc.*, 395 F.3d 1364, 1372 (Fed. Cir. 2005) ("A claim construction that gives meaning to all the terms of the claim is preferred over one that does not do so."); *cf. Phillips*, 415 F.3d at 1314 ("To take a simple example, the claim in this

[6] There is a secondary dispute between the parties as to whether a "pivot" can be a "point" or if it has to be a mechanical part. Because it does not affect the outcome, the court devotes no energy to resolving the issue.

case refers to 'steel baffles,' which strongly implies that the term 'baffles' does not inherently mean objects made of steel."). Trek also points to the specification, which describes a wheel link floating pivot as concentric with the wheel rotation axis "in certain embodiments," and "nearly concentric" "[i]n certain other embodiments." ('212 patent, 11:14-21.) Thus, like the language in the claims themselves, the specification contradicts any notion that "wheel link floating pivot" should be construed to require a "concentric with a rear wheel rotation axis of the vehicle."

Second, Split Pivot asks the court to construe "wheel link floating pivot" as "pivotally connect[ed] to the brake link." While Split Pivot claims this language has been taken "nearly verbatim" from the specification, the referenced language actually requires that the "wheel link floating pivot 6 pivotally connect[] *the wheel link* 1 to a brake link 2." ('212 patent, 4:65-67 (emphasis added).) This does not mean the same thing as construing the "wheel link floating pivot" itself to be pivotally connected to the brake link. Such a construction would be essentially the same as Trek's erroneous contention that the pivot must be fastened to the wheel link, with the brake link able to pivot around it. As already discussed, the specification provides no support for that limited construction.

Thus, the court rejects both parties' proposed constructions of "wheel link floating pivot." Instead, the court construes that term to mean "a pivot that changes its position relative to a frame member when the suspension is compressed and pivotally connects the wheel link to a brake link."

B. Brake Link Passes on Two Sides of a Frame Member

The parties also ask the court to construe the limitation "wherein said brake link passes on two sides of a frame member." This limitation is present in claims 1 and 43 of the '212 patent and their respective dependent claims. Trek contends this limitation is missing from all but a small subset of its accused bicycle models.[7]

The parties offer the following construction for this element:

Split Pivot	Trek
"brake link that moves next to or beyond two sides of a physical boundary of a frame member"	"brake link extends beyond both lateral sides of a structural support for components of a suspension system"

The parties agree that the term "passes" should be given its plain and ordinary meaning, but disagree on what that meaning is, citing to various definitions in support their own interpretation. (*See* Def.'s Br. for Summ. J. (dkt. #125) 28-29 (citing definitions such as "to go by: proceed or extend beyond"; and "to go by, beyond, over, through, or the like; to proceed from one side to the other of"); Pl.'s Resp. (dkt. #153) 26 (citing definitions such as "to move in a particular direction or to a particular place or position"; "to go past something or someone or move in relation to it or them"; and "to go onwards or move by or past").)

Split Pivot argues that "passes" is "susceptible to multiple meanings," and that a person of ordinary skill in the art would read it in this context to require only that the brake link "move to occupy a particular place next to the frame member or beyond it." (Pl.'s Resp. (dkt. #153) 26.) Split Pivot's central support for its construction is the specification,

[7] Trek apparently concede that its 2010-2013 Superfly 100, 2010-2013 Rumblefish, 2010 HiFi and 2010 Roscoe contain a "brake link [that] passes on two sides of a frame member." (*See* Resp. to PPFOF (dkt. #178) ¶¶ 116-122.)

but its arguments are muddled at best. While the specification sheds no light on the word "passes" as it relates to the brake link passing on two sides of a frame member, Split Pivot points out that the specification also uses "passes" in a similar context. For example, the description of Figure 2 states that "[t]he brake link 2 can consist of a single sided strut that passes next to only one side of a rear wheel 17 or a double sided strut that passes next to both sides of a rear wheel." ('212 patent, 6:2-5.) If Trek's construction of "passes" were applied to that portion of the specification, Split Pivot argues, the brake link would have to extend "both above and in front of and below and behind the entire[t]y of the rear wheel as illustrated below:"

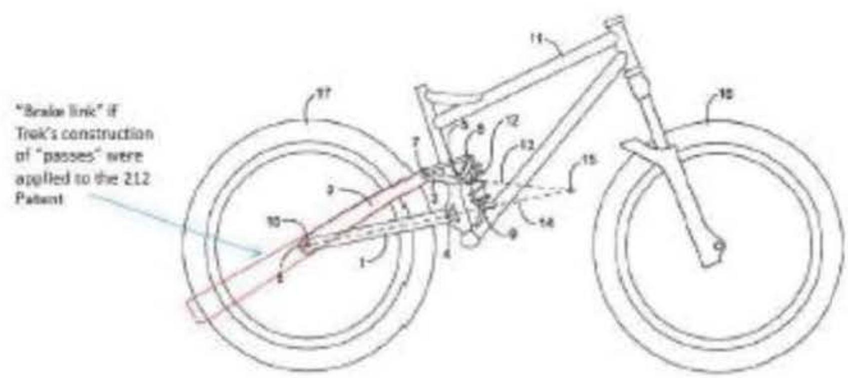


FIGURE 4

(Pl.'s Resp. (dkt. #153) 27-28.)

While consistent use of a term in the written description can inform claims construction,[8] Split Pivot appears to fundamentally misinterpret Trek's proposed construction. Trek's construction of "passes," if applied to this portion of the specification,

[8] *Cf. Nystrom v. TREX Co., Inc.*, 424 F.3d 1136, 1143-44 (Fed. Cir. 2005) (limiting "board" to wood cut from a log where "[t]hroughout the written description, Nystrom consistently used the term 'board' to describe wood decking material cut from a log").

would require only that the brake link extend beyond the left and right lateral sides of the wheel at the *front*, not that it extend beyond both front and back ends of the wheel. The context of the specification supports this interpretation, since the specification itself contemplates a brake link that can pass next to one or both "sides" of the rear wheel. If "sides" meant the front and back *ends* of the wheel, then Split Pivot's own patent would contemplate the above arrangement, which its expert has called "unorthdox, unnecessary, and counterproductive." (Expert Report of Tony Foale (dkt. #111) ¶ 85.) Split Pivot cannot ask the court to construe "passes" consistently throughout the patent while asking it to construe "sides" differently -- at least not without reason, and it offers none.

Insofar as the portion of the specification Split Pivot identifies helps either party, it helps Trek. The drawings in the '212 patent contain a brake link that not only "moves next to" the rear wheel but also extends entirely beyond it on both lateral sides of the wheel at the front end. This is to say, the drawings are at least consistent with Trek's narrower interpretation. On the other hand, the drawings are also consistent with Split Pivot's broader construction. Thus, these drawings do not definitively resolve the parties' disagreement, and the specification provides no further context for how "passes" should be interpreted.

While acknowledging the term "passes" is susceptible to multiple meanings *in general,* Trek argues that definitions of the transitive form of "passes" support its interpretation. Unfortunately, like Split Pivot's arguments, Trek's attack suffers from its own flaw: Trek contends that Split Pivot relies on an "*intransitive* form of 'passes,'" while the claims at issue "use 'passes' in its transitive form'" (def.'s Reply (dkt. #176) 9-10), but this is not quite grammatically correct. A transitive verb takes a direct object, and the claim here has none,

at least technically. Rather, "frame member" is the object of the preposition "of," part of an adjectival, prepositional phrase that modifies "sides."

Even though Trek's reasoning is flawed, the court finds its construction persuasive based on the ordinary meaning of the word "pass." Even definitions of the intransitive form of "pass" -- indeed, even some of the definitions Split Pivot cites -- carry with them the sense of proceeding beyond, or leaving something behind. *See, e.g.*, *The American Heritage Dictionary of the English Language* 1284 (4th ed. 2000) (defining the intransitive form of "pass" as "to move on or *ahead*; proceed," "to extend; run," "to move *by*," "to move *past* another vehicle") (emphasis added); *see also* Pl.'s Resp. (dkt. #153) 26 (citing definitions including "to go past something" and "to go onwards or move by or past"). A person of ordinary skill in the art, confronted with this element, would read it to require that the brake link pass -- that is, go past -- on two sides of a frame member.

Trek also argues that this limitation must be present in all states of compression; that is, the brake link must extend beyond a frame member on both sides regardless of how much the suspension has been compressed. As support, Trek points out that claims 1 and 43, in which the limitation appears, are silent as to the state of compression. In contrast, some of the other claims in the '212 patent *specify* the state of compression of the suspension. (*See, e.g.*, '212 patent, 20:15-18 ("The suspension system of claim 3, said suspension system further comprising an instant center that is below the shock absorber when the suspension is uncompressed"); 20:31-33 ("The suspension of claim 7, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is 50 percent compressed").) Thus, Trek argues, Weagle obviously knew how to provide for specific states of compression in his claims, and the court should not construe

this limitation to include embodiments in which the brake link "moves into" position upon compression.

Trek's claim differentiation argument is superficially appealing, but the implications are troubling: to hold that the brake link must pass on two sides of a frame member in all states of compression based on the dependent claims would be to *narrow* the claim by virtue of the *absence* of an additional limitation. This strikes the court as problematic, particularly since the case to which Trek cites in support not only observes that differences among claims can help guide a court in construing particular terms, but also that "the presence of a dependent claim that adds a particular limitation gives rise to a presumption that the limitation in question is *not* present in the independent claim." *Phillips*, 415 F.3d at 1315 (emphasis added); *cf. Liebel-Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 910 ("The juxtaposition of independent claims lacking any reference to a pressure jacket with dependent claims that add a pressure jacket limitation provides strong support for Liebel's argument that the independent claims were not intended to require the presence of a pressure jacket."). Trek seems to be arguing the opposite: that is, since some dependent claims recite different states of compression, the independent claim necessarily incorporates *all* of those limitations.

While an uncompressed shock absorber may well have been what the inventor contemplated for purposes of this limitation, nothing in the patent language dictates or even provides context for this reading. The specification is silent as to the shock absorber's state of compression in regard to this element. More importantly, the *claim itself* is silent as to the state of compression. Ultimately, Trek is inviting the court to read in additional limitations

and further narrow the scope of Split Pivot's claims where nothing in the patent supports those limitations.

This does not end the court's construction of this element, however, since there is also a dispute as to what constitutes a "frame member." The central disagreement between the parties is whether components of the suspension system are considered "frame members" for the purposes of this limitation. Split Pivot argues that "frame member" need not be construed, and that its plain meaning can include the links that make up the suspension system. Trek contends that frame members are separate from components of the suspension, and draws upon language from the specification defining the "frame" to offer a proposed construction of "frame member" as "structural support for components of a suspension system," presumably intended to exclude the components of the suspension system itself.

Split Pivot argues that, should the court adopt Trek's construction of "frame member," the wheel link, brake link and control link nevertheless are "frame members" since they provide structural support for one another and, thus, for other "components of a suspension system." The court agrees, at least insofar as Trek's proposed construction would introduce ambiguity into the term "frame member" that is not supported by the specification. Determining the ordinary meaning of "frame member," as understood in the context of the entire patent by a person of ordinary skill in the art, avoids the questions that would arise under Trek's proposed construction. Therefore, what remains for this court to decide is whether the ordinary meaning of "frame member" includes links of the suspension system.

As a starting point, the court notes that the specification does not suggest that the wheel, brake or control links are part of the "frame" as Weagle used that term. In fact, the specification consistently differentiates the frame and the links. For example, in describing one of the preferred embodiments, the specification states that "[a] frame 11 provides the structure for the vehicle. . . . The frame 11 provides a support or mounting location for powertrain components such as[:] engines, gears, transmissions, and fuel tanks; *suspension parts such as forks, rear suspension and front suspension*; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights." ('212 patent, 4:45-53 (emphasis added).) It goes on to specify that in that embodiment, "[a] wheel link 1 is mounted to the frame 11" ('212 patent, 4:53-54) and "the brake link 2 will transmit force to the frame 11 via the control link 3 and wheel link 1." ('212 patent, 5:5-7.) Similarly, a "control link 3 is attached to the frame 11" ('212 patent, 4:11-12), and "[t]he shock absorber 12 is mounted to the frame 11" ('212 patent, 4:18-19). This language is repeated in the description of the other preferred embodiment. (*See* '212 patent, 4:39, 42-47, 47-48, 66-67, 5:5-6, 12-13.) The consistent differentiation of the "frame" from the components of the rear suspension system throughout the specification strongly suggests that those suspension components are *not* part of the "frame," and thus they would not be "frame members" as a person of ordinary skill in the art would understand that term in context.

Still, as Split Pivot points out, the specification states that "[a] frame, in certain embodiments, may be comprised of . . . seatstays, chainstays, a seatstay, [and] a chainstay." ('212 patent, 17:23, 59.) The court agrees that in light of this explicit definition, seatstays and chainstays would be considered "frame members," since they are specifically listed as components of which a frame may be comprised. Even so, this does not prove, as Split

Pivot further contends, that wheel links and brake links are "frame members," because the court does not read "seatstay" and "chainstay" to be *synonymous* with "brake link" and "wheel link." As Trek's expert explained:

> While non-suspension bicycles include chainstays and seat stays, these frame parts are replaced by links in rear suspension bicycles. While it is common to continue to refer to these links as chainstays and seat stays for convenience, it is my opinion that one of ordinary skill in the art reading the above list in the context of the specification would not understand the listed "chainstay(s)" and "seatstay(s) to refer to a "wheel link," a "brake link," or any other link specifically named in the patent.

(Expert Report of Edward M. Caulfield (dkt. #139) ¶ 49.)

Certainly, in some contexts, a person of ordinary skill in the art would read "seatstay" and "chainstay" to refer to the components in a suspension bicycle. Indeed, Caulfield indicates that it is "common" to do so, but what is important for claims construction purposes is what a person of ordinary skill in the art would have understood those terms to mean *in light of the context of the entire patent.* The '212 patent never uses the word "seatstay" or "chainstay" in connection with the brake link and wheel link, respectively. Rather, Weagle clearly identifies the suspension components in his invention as *links*, consistently refers to them as such, and never equates "links" to "stays." Given this context, the court does not believe a person of ordinary skill in the art would then read the terms "seatstay" and "chainstay" to mean the same thing as "brake link" and "wheel link," respectively. On the contrary, the terms are neither explicitly equated, nor implicitly associated with one another, in this context.

The remainder of the specification provides further support for this interpretation. For example, in describing further embodiments of the invention, the patent provides an

extensive list of components that can comprise "[a] moving suspension component of a suspension system of the invention." ('212 patent, 17:63-18:32.) Nowhere in the list does the patent identify a "seatstay" or "chainstay" as a moving suspension component. Likewise, the specification states that "[a] vehicle using a suspension of the invention may, in certain embodiments, comprise . . . a frame, [and] a moving suspension component." ('212 patent, 15:65-16:2.) Ultimately, the court finds no support for Split Pivot's argument that a "frame member" includes the components of the suspension system itself, and so in finding that "frame member" takes its ordinary and customary meaning, the court proceeds with this distinction in mind.

C. Markush Group Limitations

Some of the claims the court has been asked to construe contain so-called Markush groups. "A Markush group is a listing of specified alternatives of a group in a patent claim, typically expressed in the form: a member selected from the group consisting of A, B, and C." *Abbott Labs. v. Baxter Pharm. Prods., Inc.*, 334 F.3d 1274, 1280 (Fed. Cir. 2003). By the use of this traditional "consisting of" language, "members of the Markush group are used singly." *Id.* at 1280-81 (quoting *Meeting Held to Promote Uniform Practice In Chemical Divisions*, 28 J. Pat. & Trademark Off. Soc'y 849, 852 (1946)). Thus, while typically an indefinite article such as 'a' or 'an' carries the meaning of "one or more," "such an indefinite article used in conjunction with a Markush grouping does *not* receive such latitude because a proper Markush group is limited by the closed language term 'consisting of.'" *Id.* at 1281 (emphasis added). "If a patentee desires mixtures or combinations of the members of the Markush group, the patentee would need to add qualifying language while drafting the

claim." *Id.* Without such express language, "a patentee does not claim anything other than the plain reading of the closed claim language." *Id.*

The '212 patent contains two different Markush groups. One is present in independent claims 1 and 22, which requires that the "shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link" ('212 patent, 20:1-3; 21:30-32) ("the Mounting Element"). The other is present in independent claims 1, 22 and 43 of the '212 patent, which requires that "said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid" ('212 patent, 20:3-5; 21:34-36; 22:58-60) ("the Shock Absorber Element"). The court will address the requirements of these Markush groups in turn.

i. The Mounting Element

The parties offer the following construction of the element "wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link":

Split Pivot	Trek
"wherein said shock absorber is mounted to one or more links selected from the group consisting of a brake link, a control link, and a wheel link"	"wherein said shock absorber is mounted to one and only one link, and no other link, selected from the group consisting of a brake link, a control link, and a wheel link"

Split Pivot contends that regardless of the patent's invocation of the Markush group language, the court should construe "a link selected from the group consisting of" to read "a link *or links* selected from the group consisting of." Split Pivot argues that no rigid rules of construction apply to Markush groups, and that in claims construction, the indefinite article

"a" is generally construed as meaning "one or more." Although Split Pivot recognizes that the word "a" used with the closed language "consisting of" generally means "only one member of a Markush group," *Abbott Labs.*, 334 F.3d at 1281, it seizes on language in *Norian Corp. v. Stryker Corp.*, 432 F.3d 1356, 1359 (Fed. Cir. 2005), in which the Federal Circuit noted that "the claim language 'consisting of . . . a sodium phosphate,' on its own, *suggests* the use of a single sodium phosphate." *Id.* (emphasis changed). Split Pivot also points out that the *Norian* court went on to analyze the specification and prosecution history of the patent at issue. In Split Pivot's view, this broader analysis when coupled with the court's use of the word "suggests," indicates that (1) Markush group language alone does not conclude the analysis of the claim scope and (2) this court must ensure a closed construction is "consistent with the specification and the history" of the patent at issue. (Pl's Opp'n to Def.'s Mot. for Summ. J. (dkt. #153) 40.) Not surprisingly, in Split Pivot's view, the specification here makes clear in two separate places that the '212 patent contemplates shock absorbers mounted to more than one link from the list.

In contrast, Trek contends that, having admitted the subject limitation is drafted in the form of a Markush group, Split Pivot cannot ignore its legal effect on the claim language. In Trek's view, *Norian* does not make the effect of the use of Markush group language a mere "suggestion"; in fact, *Norian* did not involve a traditional Markush group at all (because it lacked the "selected from a group consisting of" language); and if anything *Norian* reaffirmed the Federal Circuit's holding of *Abbott Laboratories* by citing it approvingly to support the relevant term's ultimate construction. Trek argues that (1) the law remains unchanged: Markush groups claim "one and only one" of their listed alternatives, and (2) the intrinsic evidence here supports adherence to the accepted legal analysis of Markush

groups. Split Pivot's reliance on "scraps" in the specification, Trek argues, does not salvage a construction already in conflict with the legal effect of the language of the claims themselves.

The court finds Trek's construction more persuasive. Cases like *Abbott Laboratories* have unambiguously held that Markush groups are limited by the closed term "consisting of." *See Abbott Labs.*, 334 F.3d at 1280-81. They have also held that while a patentee *may* claim combinations of the elements listed in a Markush group, such a claim is *not* the default: "the patentee would need to add qualifying language while drafting the claim" in order to get that result. *Id.* at 1281 (quoting *Meeting Held to Promote Uniform Practice In Chemical Divisions*, *supra*, which provides qualifying language examples such as "and mixtures thereof" and "at least one member of the group").

No such qualifying language is present here. The mounting element in the '212 patent claims a classic Markush group and, thus, it has "not claim[ed] anything other than the plain reading of the closed claim language."[9] *Id.*; *see also* 3 Donald S. Chisum, *Chisum on Patents* § 8.06[2], at 8-488 (2010) ("A trap for the unwary claim drafter using Markush group language is the severely closed nature of a Markush group.").

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[9] Split Pivot also argues that because the language claims "said" shock absorber, rather than "a" shock absorber, it does not represent a Markush group. (Pl.'s Resp. (dkt. #153) 53-54.) The court disagrees. As Trek accurately points out, the antecedent of "said shock absorber" is "a shock absorber." (*See* '212 patent, 19:66, 20:3.) Additionally, it is not "the single article 'a' that would theoretically trigger" the Markush group language, as Split Pivot contends. The Federal Circuit in *Abbott Laboratories* clearly stated that "a proper Markush group is limited by the closed language term 'consisting of.'" *Abbott Labs.*, 334 F.3d at 1281. In fact, Split Pivot's argument that the failure to use the word "a" necessitates a *broader* construction makes little sense, given that the word "a" is what traditionally carries the breadth of "one or more."

Split Pivot cites to two district court cases in which courts have found that Markush groups allow for the presence of multiple members: *Teva Pharmaceuticals USA, Inc. v. Amgen, Inc.*, No. 09-5675, 2010 WL 3620203 (E.D. Pa. Sept. 10, 2010), and *Bristol-Myers Squibb Co. v. Apotex, Inc.*, No. 10-5810(MLC), 2013 WL 1314733 (D.N.J. Mar. 28, 2013). In *Teva Pharmaceuticals*, the district court construed the claim language "having an amino acid sequence from the group consisting of" to allow for the presence of more than one amino acid sequence. *Teva Pharm.*, 2010 WL 3620203, at *7. It distinguished *Abbott Laboratories* on the grounds that *Abbott Laboratories* involved a claim for a Lewis acid inhibitor *in an amount sufficient to prevent degradation*. The mixture of two Lewis acid inhibitors to reach the efficacy level was therefore not what the patentee had claimed. *See id.* (interpreting *Abbott Laboratories.*). Thus, the *Teva Pharmaceuticals* court held that "[a]lthough Amgen's patents must have an effective amount of *one* of the versions of the patented polypeptide present in the product, it does not mean that *only* one of the patented versions may be present." *Id.*

As an initial matter, this court notes that the Federal Circuit has not yet endorsed the view of the *Teva Pharmaceuticals* court. As a result, this court remains bound by *Abbott Laboratories*, which states unambiguously enough that members of a Markush group, absent express qualifying language, are used singly. *See Abbott Labs.*, 334 F.3d at 1281. Additionally, to the extent that the *Teva Pharmaceuticals* court's reasoning is applicable, it is for the proposition that a Markush group indicates a single member of the group *carries out the given function*. *See Teva Pharm.*, 2010 WL 3620203, at *7. This is consistent with the long-standing purpose of Markush groups, which recite members that are "*alternatively* useable for the purposes of the invention." *Abbott Labs.*, 334 F.3d at 1280 (quoting *In re Driscoll*, 562 F.2d 1245, 1249 (C.C.P.A. 1977) (emphasis added)). Applying the reasoning

of *Teva Pharmaceuticals* in light of the purpose of Markush group language in this case, the drafter here chose language indicating that the claimed suspension system requires the shock absorber to be mounted to a link; any one of the three enumerated links would be "alternatively useable" for the system's purposes. *Id.* Two or more links serving that same function, in contrast, is not what the inventor claimed.[10]

Though the plain language claims only suspension systems with a shock absorber mounted to one and only one of the listed links, Split Pivot contends that two places in the specification indicate that "a link selected from the group" must be construed as "one or more links selected from the group." First, a general statement in the specification reads, "Throughout this application the singular includes the plural and the plural includes the singular, unless indicated otherwise." ('212 patent, 19:59-61.) This statement does not help Split Pivot, since the Markush group language itself and the closed nature of "consisting of" represents just such an indication to limit "a" to its singular sense. *Cf. Norian Corp.*, 432 F.3d at 1359 (noting that though generally the word "a" means "one or more," the general rule does not apply "when, as in this case, it has been used in conjunction with the closed transitional phrase 'consisting of'"). Second, Split Pivot points

[10] Perhaps recognizing this problem with its argument, Split Pivot asks the court to construe only the words "a link selected from the group," stating that construction of the word "mounted" is "unnecessary" and that "[i]f the words 'mounted to' are left out of the language being construed, the claim, as written, will not preclude the shock absorber from being connected to just one of 'a brake link, a control link, and a wheel link' at a first end and also being connected at its second end to some other structure, including one of the remaining two enumerated links." (Pl.'s Resp. (dkt. #153) 43). Split Pivot offers no authority for the proposition that the court can or should selectively construe only a portion of a claim's language in order to alter that claim's construction, nor does the court find a good reason to do so -- particularly since interpreting claim language requires reading the claim term "not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent." *Phillips*, 415 F.3d at 1313.

to another statement in the specification, which reads, "In certain embodiments, a shock absorber is mounted to a brake link and/or a control link in a pivotal manner." ('212 patent, 2:34-36.) The use of "and," Split Pivot contends, would make clear to a person of ordinary skill in the art that a shock absorber could be mounted to more than one link. Even if the court were to take this as true, "[s]pecifications teach. Claims claim." *Oak Tech., Inc. v. Int'l Trade Comm'n*, 248 F.3d 1316, 1329 (Fed. Cir. 2001). The language chosen by the patentee is closed language, and just as the court cannot read limitations from the specification into the claims, neither can it *broaden* the claims beyond the language used in them based on a disclosure in the specification that does not fall within that claim. *See Autogiro Co. of Am.*, 384 F.2d at 396 ("Courts can neither broaden nor narrow the claims to give the patentee something different than what he has set forth.").

Had Split Pivot wished, it could have claimed a shock absorber mounted to "at least one link selected from the group." Split Pivot's failure to qualify its claim, however, has limited the invention to systems in which the shock absorber is mounted to one of the three listed links, each of which are usable in the alternative. The court declines to read out that language.

Contrary to Split Pivot's selective quotation, the specification is also generally consistent with a narrow interpretation of this element. While the description of "Shock Absorbers of Suspension Systems of the Invention" is silent as to where the shock absorber is mounted ('212 patent, 13:9-31), none of the drawings in the '212 patent features a suspension system in which the shock absorber is mounted to both the control link and the brake link, such that the narrow construction would exclude "preferred embodiments" or run afoul of general rules of claims construction in some other way. Rather, in figures 1 and

3, the shock absorber is mounted to the brake link on one side and the frame on the other; in figures 2, 4, 5 and 6, the shock absorber is mounted to the control link on one side and the frame on the other. The detailed description confirms this understanding. (*See* '212 patent, 5:18-20 ("The shock absorber 12 is mounted to the frame 11 via a second shock pivot 9."); 6:12-14 (same).) The court cannot read that limitation into the claims, *see Golight, Inc.*, 355 F.3d at 1331, but in this case, the limitation is "imposed by the claim language itself, and the written description simply confirms this understanding."[11] *Oak Tech., Inc.*, 248 F.3d at 1328-29.

Finally, Split Pivot proffers expert testimony to demonstrate that a person of ordinary skill in the art would read the claim language to allow for the shock absorber to be mounted on two links from the list. Such testimony, as extrinsic evidence, is less helpful in claims construction than the intrinsic evidence of the claim language, the specification and the prosecution history. *Phillips*, 415 F.3d at 1317. Thus, it must be considered in the context of the intrinsic evidence to be reliable. *Id.* at 1319.

Split Pivot's expert, Tony Foale, opined in his expert report that "[a] person of ordinary skill in the art . . . would have known that a shock absorber has two mounting

[11] It is true that the '301 patent is a continuation in part of the '212 patent, and the '301 patent discloses one embodiment in which the shock absorber is mounted to the wheel link and the control link. (*See* '301 patent, Figure 11.) Generally, identical or indisputably interchangeable claim terms that share a common ancestry should be construed consistently. *See AbTox, Inc. v. Exitron Corp.*, 131 F.3d 1009, 1010 (Fed. Cir. 1997). The court is aware of no case law suggesting that the claims of a *parent* patent should be construed in light of the drawings of the *child* continuation-in-part, particularly since continuations in part allow for the addition of new matter. Because claims with common ancestry should generally be construed consistently, and because the language surrounding the Mounting Element is identical between the '212 and '301 patents, the court concludes that the embodiment disclosed in Figure 11 is an embodiment "disclosed but not claimed." *Johnson & Johnson Assocs. Inc. v. R.E. Serv. Co. Inc.*, 285 F.3d 1046, 1051 (Fed. Cir. 2002).

points and thus of necessity it must be mounted to two components." (Foale Report (dkt. #111) ¶ 75.) While this may be true, Foale himself admits that it *could* be mounted either to another link or to the bicycle's frame. (*Id.*) Given that the specification only describes embodiments and includes drawings in which the shock absorber is mounted to one link and to the frame, Foale's assertion that a person of ordinary skill in the art would have read "a link" to read "one or more links" is unconvincing. Stated another way, while the court does not quarrel with Foale's assertion that a person of ordinary skill in the art would know that a shock absorber needs two mounting points, there is no indication that such a person would read this language, in light of the specification and the Federal Circuit's construction of a Markush Group, to claim not only configurations wherein the shock absorber was mounted to one link and the frame, but also configurations wherein the shock absorber was mounted to two links.

Therefore, the court construes the Mounting Element "wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link" to mean "wherein said shock absorber is mounted to one, and only one, link selected from the group consisting of a brake link, a control link, and a wheel link."

ii. The Shock Absorber Element

The parties offer the following construction of the element "wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid":

Split Pivot	Trek
"wherein said shock absorber consists of	"wherein said shock absorber consists of

one, or more, of a compression gas spring, leaf spring, a coil spring, and a fluid"	one, and only one, of the following: a compression gas spring, a leaf spring, a coil spring, and a fluid"

A version of this element also appears in the '301 patent and reads, "wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid." The parties' proposed constructions of this version of the term do not materially differ from the '212 patent version: Split Pivot asks the court to construe the language to encompass one or more of the listed elements; Trek argues that Split Pivot should be limited to one, and only one, of the elements listed.

Split Pivot's argument differs in one material respect, however, contending that the plain and ordinary meaning of the term "shock absorber" necessarily encompasses *both* a spring and a damper, and that it cannot be held to a narrower meaning without "specific expressions of manifest exclusion or restriction." (Pl.'s Resp. (dkt. #153) 57.) As support, Split Pivot again proffers the testimony of its expert, Foale, who opined that "[a]t the time of the invention, a person of ordinary skill in the art would have understood a shock absorber to necessarily include a springing medium like a gas spring or a coil spring, and a fluid for damping. . . . Considering the colloquial language of the art, it is inconceivable that anyone of ordinary skill in the art would assume that describing a shock absorber by its springing method only would mean that it was without a fluid damping system. Such a construction would render the Trek version of a shock absorber something other than a shock absorber." (Expert Report of Tony Foale (dkt. #111) ¶ 69.) Split Pivot argues that the specification makes clear that the patents intended to claim the plain and ordinary meaning of "shock absorber," rather than an embodiment that contains just one of the

listed elements and thus falls outside that scope. (*See* '212 patent, 18:53-19:7 (listing items that may comprise a "motion control device" of the invented suspension system).)

Trek does not dispute that "combination" shock absorbers -- those made from both a spring and a fluid damper -- were "well known in the art" at the time of the patent application was made. (Def.'s Reply (dkt. #176) 19.) Additionally, Trek "agrees that the recitation in the specifications of the patents in suit of a general 'shock absorber,' could refer to such a combination shock absorber." (*Id.*) Trek relies instead on the rules governing the use of Markush group language to argue that -- even assuming combination shock absorbers were well-known in the art -- the patents exclude combination shock absorbers from what is claimed.

As above with the Mounting Element, Split Pivot has claimed a classic Markush group. Per *Abbott Laboratories*, this means that it has claimed suspension systems wherein the shock absorber is made from one and only one of the listed equivalents, any one of which would be "alternatively usable" for the purposes of the claimed suspension system. Without express language allowing for combinations of the elements listed to accomplish that same function, the plain language of the claims simply does not encompass combination shock absorbers.

Even the specification lists the claimed elements in alternative form: the summary of the invention states that "[a] shock absorber, in certain embodiments, may be a damper, a spring, a compression gas spring, a leaf spring, a coil spring, or a fluid." ('212 patent, 2:28-30.) The description of "Shock Absorbers of Suspension Systems of the Invention" likewise employs the disjunctive. (*See* '212 patent, 13:13-15.) "The disjunctive 'or' plainly designates that a series describes alternatives." *SkinMedica, Inc. v. Histogen Inc.*, 727 F.3d

1187, 1199 (Fed. Cir. 2013) (citing *Kustom Signals, Inc. v. Applied Concepts, Inc.*, 264 F.3d 1326, 1331 (Fed. Cir. 2001)).

Additionally, the prosecution history suggests a narrower interpretation may be appropriate. Initially, the patents claimed only a "shock absorber"; the Shock Absorber Element was not present in any of the claims. (*See* '212 file history (dkt. #158-29) SP 0000163-172.) The claims were allowed in this state, subject to certain amendments that did not include the Shock Absorber Element. (*See id.* at SP 0000181-185.) Thereafter, the applicant submitted his own amendments adding the Shock Absorber Element to each independent claim, using the Markush group format. (*See id.* at SP 0000199-208.) In his remarks, the applicant indicated that the claims were "amended to more particularly point out and more distinctly claim the subject invention." (*Id.* at SP 0000209.) While this is not an instance in which the applicant necessarily amended claims to avoid a rejection, he at the least intentionally restricted the scope of his invention and intended only to claim systems including a shock absorber selected from that particular group -- despite the presence of a far broader list of possible "motion control devices" in the specification.[12] (*See* '212 patent, 18:53-19:7.)

The court's decision to adopt Trek's construction of the Markush group terms with respect to shock absorbers may seem unduly restrictive, particularly in light of Trek's

[12] The court notes that the specification at one point states that "[a] suspension system of the current invention, in certain embodiments, comprises a shock absorber, or two, three, four, five or more shock absorbers." ('212 patent, 13:11-13.) Given the court's construction of "shock absorber" as one, and only one, of the listed elements, the specification would seem to support arrangements in which the presence of both a single "shock absorber" (for example, a spring) *and* a second "shock absorber" (for example, a fluid) would not defeat infringement. Split Pivot does not, however, make this argument. Perhaps more importantly, crediting this interpretation would provide a "back door" around the closed Markush group language that the patentee actually chose.

concession that combination shock absorbers are well-known in the art. But such a restrictive interpretation is in keeping with the "severely closed nature" of the language chosen by the patentee, which has been described as a "trap for the unwary drafter." 3 Donald S. Chisum, *Chisum on Patents* § 8.06[2], at 8-488 (2010). As the law currently stands, *Abbott Laboratories* states that without express language claiming combinations of Markush group members, a patentee has claimed embodiments featuring one, and only one, member. The applicant made the decision to employ this language, and the court will not and cannot read it out of these claims.

D. Force "Transmitted Through Said Brake Link"

The parties also dispute the proper construction of the limitation, present in all asserted claims of the '212 patent and in claim 37 of the '301 patent, that the force that compresses the shock absorber be "transmitted through" the brake link ("the Transmission Element").[13] The parties offer the following constructions:

Split Pivot	Trek
"the force that compresses said shock absorber is transmitted directly or indirectly through said brake link"	"the force that compresses said shock absorber is provided by the brake link to the shock absorber"

The court agrees with Split Pivot that the ordinary meaning of the word "transmit" is not limited to *direct* transmissions. The word does not itself require that any transmission of force be direct, and even Trek admits that, at least in *some* contexts, "transmit" "could

[13] The wording of this limitation differs very slightly between claims 1 and 22, which state that "force that compresses said shock absorber is transmitted through said brake link," and claim 43, which states that "force is transmitted to said shock absorber through the brake link." For the most part, the parties treat this language the same across all three claims. To the extent they do attempt to draw a distinction, that will be discussed in this section.

include an indirect transmission." (Def.'s Reply (dkt. #176) 23.) While Trek does qualify this concession by arguing that "transmit" is ambiguous when read alone and that "in some contexts it requires a direct transmission," (Def.'s Reply (dkt. #176) 23), Trek offers no support for its narrow plain-meaning construction and no reason why such a limited definition would be appropriate in this case. As Split Pivot points out, a patentee "is free to choose a broad term and expect to obtain the full scope of its plain and ordinary meaning unless the patentee explicitly redefines the term or disavows its full scope." *Thorner v. Sony Computer Entertainment Am., LLC*, 669 F.3d 1362, 1367 (Fed. Cir. 2012). Given the broad meaning of the term "transmit," the court finds Split Pivot's construction better reflects the plain meaning of the language as read by a person of ordinary skill in the art.[14]

Certainly, as Trek points out, a person of ordinary skill in the art is "deemed to read the claim term . . . in the context of the entire patent, including the specification." *Phillips*, 415 F.3d at 1313. The court finds, however, that the specification actually provides further support for *Split Pivot's* construction of the Transmission Element. For instance, the description of Figure 1 uses variations of the term "transmit" to refer to *indirect* transmissions. (*E.g.*, '212 Patent, 5:5-8 ("[T]he brake link 2 will transmit force to the frame 11 *via the control link 3 and wheel link 1*. Force is transmitted through the links *via the link fixed and floating pivots* 4, 5, 6, and 7.").) If the meaning of the word "transmit" was limited to *direct* transmissions, then it would be impossible for the brake link to "transmit" force to the frame *via* other components. These descriptions are not limited to Figure 1; the description

[14] Indeed, the Federal Circuit has previously construed the word "transmit" in the context of satellites, finding that because "[n]either the claim language nor the patent specification requires that the . . . transmission be direct," the term was properly construed as "encompassing . . . 'transmitting, whether direct or indirect.'" *SiRF Tech., Inc. v. Int'l Trade Comm'n*, 601 F.3d 1319, 1330 (Fed. Cir. 2010).

of Figure 2 likewise states that "the brake link 2 will transmit force to the frame 11 *via the control link 3 and wheel link 1*." ('212 Patent, 5:66-6:1.) Far from "explicitly redefin[ing] the term" or "disavow[ing] its full scope," Split Pivot has used the term through the specification in a manner consistent with the ordinary, broad definition of the word "transmit." *See Autogiro Co. of Am. v. United States*, 384 F.2d 391, 397 (Ct. Cl. 1967) ("[T]he specification aids in ascertaining the scope and meaning of the language employed in the claims inasmuch as words must be used in the same way in both the claims and the specification.").

Trek finds support for its narrow construction of the Transmission Element from a different portion of the specification, which states that "[i]n certain embodiments, a shock absorber is mounted to a brake link and/or a control link in a pivotal manner, and preferably so that a force that compresses or extends the shock absorber is transmitted through a brake link *or* a control link." ('212 patent, 2:34-38) (emphasis added). Trek emphasizes the word "or" as indicating that the patent discloses just two possibilities: one in which the shock absorber is *directly* connected to the brake link and another in which it is *directly* connected to the control link. Trek further argues that Figure 3 embodies the first possibility, with the brake link directly connected to the shock absorber, and that Figure 4 embodies the second possibility, with a control link directly connected to the shock absorber. To read otherwise, Trek contends, would destroy the difference between the two embodiments, since *both* possibilities would have a brake link that "transmits" force to the shock absorber (Figure 3 directly, and Figure 4 indirectly). The word "or" would thus be rendered meaningless.

One flaw in Trek's argument is that the descriptions in Figures 3 and 4 (or Figures 1 and 2, on which they are based) have no limiting language indicating that *only* Figure 3 has a brake link that "transmits" force to the shock absorber and that Figure 4 *lacks* a brake link that "transmits" force to the shock absorber. In fact, as discussed above, the descriptions of Figures 1 and 2 both use the word "transmit" to encompass indirect transmission in other contexts. The court finds further support for this interpretation by the juxtaposition of the broader "transmit," which allows for transmission via different components, with the description's other requirement that "[f]orce from the brake will be *transferred directly* into the brake link 2." ('212 patent, 5:4-5, 65-66.) Even were the court to ignore this more compelling language in the descriptions, Trek's construction ultimately proposes to limit the plain meaning of the term "transmit" based on a portion of the specification when, as previously explained, it is axiomatic that "limitations from the specification are not to be read into the claims," *Golight, Inc.*, 355 F.3d at 1331.

Furthermore, Split Pivot points out that to construe "transmit" to encompass only direct transmission would effectively exclude numerous disclosed embodiments of the invention -- namely, figures 2, 4, 5, and 6, which do not feature a direct connection between the brake link and the shock absorber, but instead include an intervening control link. (Pl.'s Br. in Support of Mot. for Summ. J. (dkt. #114) 17.) Both Split Pivot's and Trek's experts agree that Trek's construction would exclude these embodiments from the scope of the claims.[15] (*See* Caulfield Report (dkt. #104) 16; Foale Report (dkt. #111) 35.) Courts "normally do not interpret claim terms in a way that excludes disclosed examples in the

[15] All of the claims of the '212 patent contain the limitation that force be "transmitted through" the brake link. (*See* dkt. #133-1.)

specification." *ArcelorMittal France v. AK Steel Corp.*, 700 F.3d 1314, 1321 (Fed. Cir. 2012) (quoting *Verizon Servs. Corp. v. Vonage Holdings Corp.*, 503 F.3d 1295, 1305 (Fed. Cir. 2007)). Given the breadth of the term's ordinary meaning, and the fact that the specification uses the word "transmits" to encompass indirect transmission, the court finds no basis to interpret it in a way that excludes four of the seven disclosed embodiments.

Trek also argues that Weagle disclaimed indirect transmission during the patent's prosecution. Specifically, Trek notes that the examiner rejected claims over U.S. Patent Publication No. 2003/0038450 ("the Lam reference") during prosecution of the '212 patent, which had a configuration wherein the shock absorber was connected to the control link, rather than directly to the brake link. Trek argues that in thereafter amending his claims to include the requirement that "force that compresses said shock absorber is transmitted through said brake link," Weagle surrendered any *indirect* transmission of force to the shock absorber.

The prosecution history does not ultimately help Trek. While Trek is correct in that many of the '212 patent's claims were initially rejected over Lam, as Split Pivot points out, following a telephone conference, "[i]t was agreed that the prior art references used in the previous office action [including Lam] do not read on the claims, as the art does not disclose a wheel link floating pivot which is concentric with the wheel rotation axis." ('212 file history (dkt. #158-29) SP 0000162.) Thus, it is not at all clear that by accepting the examiner's eventual amendment to include the Transmission Element in additional claims, Weagle was disavowing embodiments involving an *indirect* transmission of force in order to overcome a rejection over prior art.

In addition, the court actually finds some *support* for Split Pivot's interpretation in the prosecution history. "[P]rosecution history provides evidence of how the PTO and the inventor understood the patent." *Phillips*, 415 F.3d at 1317. Here, that history suggests that both the PTO and Weagle understood the element "wherein force is transmitted to said shock absorber through said brake link" to encompass both direct and indirect transmission. For example, as Trek points out, the Lam reference discloses a configuration that is very similar to figures 2 and 4 of the '212 patent, involving a brake link attached to a control link, which attaches to a shock absorber.

(Left "Figure 1": Lam reference; Right "Figure 5": '212 patent)

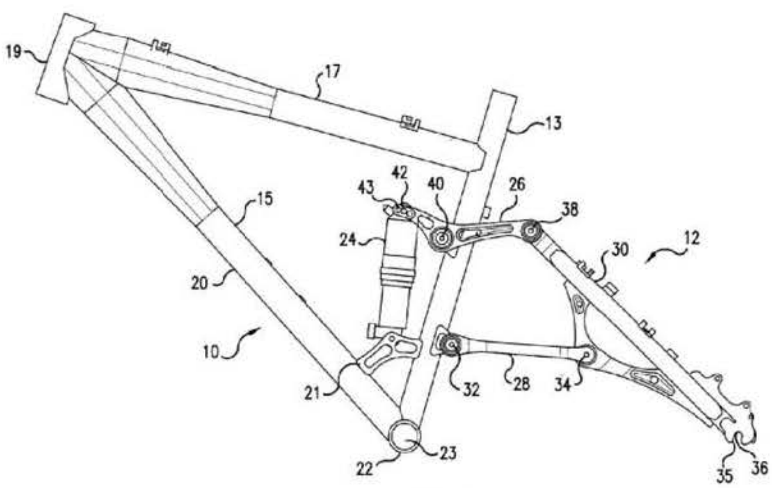

FIG.1

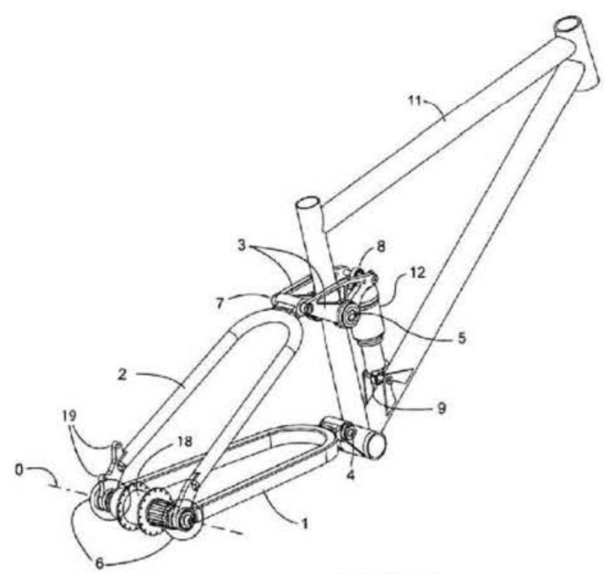

FIGURE 5

In his original *rejection* of the '212 patent over Lam, the patent examiner noted that Lam "discloses . . . a control link (26) . . . wherein force is transmitted to the shock absorber through the brake link (via 26)." ('212 file history (dkt. #158-29) SP 0000153-54.) This strongly suggests that the patent examiner viewed the element requiring the brake link to transmit force to the shock absorber to encompass embodiments in which the transmission was indirect, by means of the intervening control link. While less important than the language and specification, this provides further support for a broad construction of the Transmission Element.

It is not clear to the court whether Trek intends to draw a distinction between the element "force that compresses said shock absorber is transmitted through said brake link," which appears in claims 1 and 22 of the '212 patent, and the slightly simpler "force is transmitted to said shock absorber through the brake link" of claim 43. Indeed, it offers essentially the same construction for both terms. (*See* Def.'s Br. in Support of Summ. J. (dkt. #125) 44 (construing both elements to require force to be "provided by the brake link to the shock absorber"). To the extent that Trek draws a distinction between the two, the court does not. To the simpler formulation of claim 43, claims 1 and 22 simply add the subordinate clause "that compresses said shock absorber," which further describes the type of force in question. Trek argues that through this addition, Weagle "disclaimed a broader construction of this limitation that would allow for the shock absorber to be compressed by components other than the brake link." (*Id.* at 47.) This argument fundamentally misinterprets the claim language. The subordinate clause "that compresses said shock absorber" modifies the word "*force*," not the word "*brake link*." Thus, the shock absorber

must be compressed by "force," and that force must be "transmitted through" the brake link. Nothing in that language requires the *brake link itself* to compress the shock absorber.

Thus, based on the plain meaning of "transmits" to a person of ordinary skill in the art and the supporting context of the specification and prosecution history, the court adopts Split Pivot's proposed construction and construes "transmits" to encompass both direct and indirect transmissions.

E. Leverage Ratio Curve Element

Each asserted claim of the '301 patent contains a limitation that is directed toward "leverage ratio curves" achieved by the claimed suspension systems; these limitations are not present in the '212 patent claims. Specifically, the claims cover suspension systems wherein the leverage ratio curve "has a negative or a positive slope in the beginning 1/3 (third) [of the leverage ratio curve] and in the end 1/3 (third), and a change in slope value in the middle 1/3 (third)."[16] ('301 patent, 34:18-21.)

i. "Has a Negative or a Positive Slope"

First, the parties disagree on the correct construction of the phrase "has a negative or a positive slope":

Split Pivot	Trek
"has a negative and/or a positive slope, and may include a zero slope"	"has only a negative or a positive slope, and does not include both a negative and a positive slope or a zero slope"

[16] The slope of a line, in purely mathematical terms, is the ratio of the projection on the y-axis (vertical) of a segment of a graph to its projection on the x-axis (horizontal); that is, its vertical "rise" over the horizontal "run."

In support of its construction, Trek argues that the plain meaning of the word "or" does not embrace the meaning of "and"; that is, the claim language covers one possibility or the other, but not both. Thus, even though the specification discloses embodiments in which the beginning one-third and the end one-third of the leverage ratio curve have some combination of negative, positive, and zero slope, the plain language *claims* only embodiments in which the beginning and end thirds have a solely positive or solely negative slope. Trek also argues that Weagle disclaimed embodiments with a zero slope in the beginning or end thirds of the curve during prosecution, which also means he disclaimed any embodiments in which the slope changes from positive to negative or vice versa in those thirds (since a change from positive to negative requires a point at which the slope is zero).

Split Pivot argues that the plain meaning of the word "or" can embrace the possibility of both options, such that "or" means "either or both." In support for this interpretation, Split Pivot points out that the specification discloses embodiments having both a negative and positive slope in the same one-third of the leverage ratio curve:

> In certain embodiments, a beginning ⅓ can comprise a positive slope, zero slope, and or a negative slope. In certain embodiments, a middle ⅓ can comprise a positive slope, zero slope, and or a negative slope. In certain embodiments, an end ⅓ can comprise a positive slope, zero slope, and or a negative slope. . . . Certain preferred embodiments can comprise a beginning ⅓ with a positive and negative slope, a middle ⅓ with negative and zero slope, and an end ⅓ with a positive slope. Certain preferred embodiments can comprise a beginning ⅓ with a positive and negative slope, a middle ⅓ with negative and zero slope, and an end ⅓ with a more negative slope.

('301 patent, 33:31-48.) Thus, read in context, Split Pivot contends that the claim language contemplates curves with any combination of negative, positive and zero slopes in the beginning and end thirds. Split Pivot also argues that since there is no "clear and

unmistakable" disavowal of claim scope in the prosecution history, the claim language must be construed broadly.

As both Split Pivot and Trek recognize, the specification discloses embodiments in which the beginning and end thirds of the leverage ratio curve are not limited to either positive or negative slopes. "[A] claim construction that would exclude the preferred embodiment 'is rarely, if ever, correct and would require highly persuasive evidentiary support.'" *Rexnord Corp.*, 274 F.3d at 1342 (quoting *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1583 (Fed. Cir. 1996)). Such a construction may nevertheless be correct if the unambiguous language of a claim that was amended to overcome a rejection compels an interpretation that excludes the preferred embodiment. *See Elekta Instrument S.A. v. O.U.R. Scientific Intern., Inc.*, 214 F.3d 1302, 1308 (Fed. Cir. 2000).

Here, as Trek points out, Split Pivot originally submitted claims that stated the disputed element as:

> ...wherein said leverage ratio is exemplified as a curve, said curve having a slope. and said slope in a beginning 1/3 selected from the group consisting of a positive slope, a zero slope, and a negative slope, said slope in a middle 1/3 selected from the group consisting of a positive slope, a zero slope, and a negative slope, and said slope in an end 1/3 selected from the group consisting of a positive slope, a zero slope, and a negative slope.

('301 patent file history (dkt. #158-32) SP 0000497.)

The examiner rejected the claims containing this element over Miyakoshi, noting:

> It is well-known in the art that the shock absorber force at the wheel is related to the shock absorber force multiplied by the leverage ratio. Accordingly, any graph can be broken down into three equal parts and, because lines on a graph *must have a positive, negative, or zero slope,* the Miyakoshi reads in each of the selected groups provided for in claims 98, 106 and 114.

('301 patent file history (dkt. #158-32) SP 0000512.) Thereafter, Split Pivot submitted amended claims in which the original language was replaced by the current language, which requires the first and last thirds of the curve to have "a negative or a positive slope." (*See* '301 patent file history (dkt. #158-32) SP 0000525-0000549.)

Based on the foregoing exchange, Trek argues, prosecution history estoppel precludes Split Pivot from claiming suspension systems with curves that have a zero slope in the first and last thirds -- and thus precludes Split Pivot from claiming curves with a *change* from negative to positive or vice versa in the first and last thirds as well, since such a change requires the curve to have a zero slope at some point.

Prosecution history estoppel "requires that the claims of a patent be interpreted in light of the proceedings in the PTO during the application process." *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 535 U.S. 722, 733 (2002). When a claim has been rejected, that rejection indicates that the patent examiner did not believe it could be patented in its original form. *Id*. at 734. "While the patentee has the right to appeal, his decision to forgo an appeal and submit an amended claim is taken as a concession that the invention as patented does not reach as far as the original claim." *Id.*

Here, the court agrees with Trek that, having chosen to amend the claims to remove the possibility of a zero slope in the curve's first and last thirds to overcome the examiner's rejection, Split Pivot cannot now claim embodiments that may *include* a zero slope in the curve's first and last thirds. Moreover, because a line in which the slope changes from positive to negative or negative to positive has a zero slope at the point of change, Split Pivot conceded by amendment to limit its claims to only those suspension systems with

leverage ratio curves that have *only* a positive or negative slope in the first and last thirds.[17] While recognizing that constructions excluding preferred embodiments are disfavored, this appears that "rare case" where Split Pivot's decision to amend its claims compels such an interpretation. *Cf. Elekta Instrument S.A.*, 214 F.3d at 1308 (adopting construction that excluded the "preferred and only embodiment disclosed in the specification" where prosecution history made clear that applicant had changed claim language to overcome obviousness rejection).

Split Pivot's *only* argument against a finding of prosecution history estoppel with respect to this amendment is that the '301 patent does not include "clear and unmistakable" language disavowing claim scope. *Plantronics, Inc. v. Aliph, Inc.*, 724 F.3d 1343, 1350 (Fed. Cir. 2013). Split Pivot's apparent contention that Trek must point to particular *language*, however, is misplaced. Even the case Split Pivot cites does not require particular language for prosecution history estoppel to apply. *See id.* ("[W]hen the patentee unequivocally and unambiguously disavows a certain meaning to obtain a patent, the doctrine of prosecution history disclaimer narrows the meaning of the claim consistent with the scope of the claim surrendered."). Here, the court finds that Split Pivot's decision to amend its claim language to remove the *possibility* of a zero slope is unmistakably an effort to overcome the examiner's rejection, which was predicated on a finding that all lines must have either a positive, negative or zero slope.[18]

[17] Mathematically, it is certainly possible for a line to change from positive to negative slope (or vice versa) without the line having a zero slope at any point. The parties have agreed here (perhaps as a practical matter given the curves in question) that it is impossible to have both a positive and negative slope without going through a zero slope. (*See* Reply to DPFOF (dkt. #177) ¶ 154.)

[18] The fact that the remarks that accompanied the amendments state that they are made

Additionally, the court finds additional support for Trek's construction in the realm of common sense. Split Pivot asks the court to read "a negative or a positive slope" as "negative, positive and/or zero." As the examiner initially pointed out, under this construction, all leverage ratio curves, without exception, would meet this "limitation," since lines can *only* have some combination of positive, negative and zero slope. (*See* Expert Report of Edward M. Caulfield (dkt. #139) ¶ 59 ("[T]he patent specification describes the full set of potential leverage ratio curves achievable in *any* suspension." (emphasis added).) Split Pivot's construction would therefore render the limitation "meaninglessly empty." *Ethicon Endo-Surgery, Inc. v. U.S. Surgical Corp.*, 93 F.3d 1572, 1578. In this sense, Split Pivot's argument "proves too much," *id.*, or, at least, Split Pivot was willing to concede as much rather than fight this examiner's reasoning on this point. Split Pivot must now accept the consequences of that choice. Accordingly, the court adopts Trek's construction.

ii. "Change in Slope Value"

The parties also disagree on the proper construction of "change in slope value," which the '301 patent requires in the middle third of the leverage ratio curve of a suspension system:

Split Pivot	Trek
"change in the slope of a curve plotted on a Cartesian graph where slope is the change in Y value divided by the change in X value	"change between positive, negative, or zero slope"

"[w]ithout acquiescing in the rejections or the grounds therefor, and solely to expedite prosecution" ('301 patent prosecution history (dkt. #158-32) SP 0000549), does not change the court's analysis. If overcoming prosecution history estoppel were as simple as including such boilerplate language with each amendment, the doctrine would be eviscerated.

over an identical and correlating small incremental wheel travel distance"	

Trek argues that one of ordinary skill in the art would understand the term "slope value" to refer to a positive, negative or zero slope. It points out that the leverage ratio curve limitations describe only two potential "values" for the first and last thirds of the curve: positive and negative. Thus, a person of ordinary skill in the art would understand that the "change in slope value" in the middle third meant a change between those two values -- that is, a change from positive to negative slope, or vice versa.

Split Pivot argues that Trek's construction "confuses the concepts of slope sign and slope steepness." (Pl.'s Resp. (dkt. #153) 69.) By slope *value*, is meant to refer to the calculated magnitude or steepness (i.e., the rise over the run) of the curve's slope, and supports its proposed construction by pointing out that the specification describes an embodiment in which the middle third of the curve has "a less positive slope" ('301 patent, 33:38), and that another embodiment describes a curve whose end third has a "more negative slope" ('301 patent, 33:47-48). If slope value meant slope *sign*, Split Pivot contends, then there could be no such thing as a "less positive" or "more negative" slope.

Read in the context of the full patent, the court agrees with Trek that in the context of the '301 patent, a person of ordinary skill in the art would read "change in slope value" to refer to a change in slope sign, rather than any mathematical change at all in the steepness of the slope. The context provided by the dependent claims supports this construction. For instance, asserted independent claim 29 uses the general language requiring a "negative or a positive slope" in the beginning and end thirds of the curve, with

a "change in slope value" in the middle third. Claim 35, which depends from claim 29 and adds an additional leverage curve limitation, reads:

> The suspension system of claim 29, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

('301 patent, 37:48-51.) Claim 36, which also depends from claim 29 and is the only other one of claim 29's dependent claims to add a leverage curve limitation, reads:

> The suspension system of claim 29, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

('301 patent, 37:52-55.) This context suggests that the "change in slope value" refers to the change from negative to positive, in claim 35, and positive to negative, in claim 36. Claim 37, another asserted independent claim, provides the same context: dependent claim 44 specifies a negative-to-positive leverage curve, and dependent claim 45 specifies a positive-to-negative leverage curve. (*See* '301 patent, 38:35-42.) In fact, all of the claims follow this same pattern. (*See, e.g.*, '301 patent, 39:33-40; 40:34-41; 41:20-27; 42:14-21, 57-64; 44:12-19.) Read in context, "change in slope value" appears to mean a change in the slope sign, rather than any possible change in slope.

Still, as Split Pivot points out, the specification refers to embodiments in which the *slope* of a leverage ratio curve is "less positive" or "more negative." The specification does not, however, state that the slope *value* is "less positive" or "more negative." Indeed, as Trek points out, the term "slope value" does not appear in the specification at all. It is therefore reasonable that a person of ordinary skill in the art, reading the entirety of the patent, would understand that "slope," as the result of a mathematical calculation, can be "less

positive" or "more negative," but that a "change in slope value" means a change from positive to negative or vice versa. The court, therefore, adopts Trek's construction of this element.

III. Infringement and Non-Infringement

"Infringement, whether literal or under the doctrine of equivalents, is a question of fact." *Absolute Software, Inc. v. Stealth Signal, Inc.*, 659 F.3d 1121, 1129-30 (Fed. Cir. 2011) (citing *Bai v. L & L Wings, Inc.*, 160 F.3d 1350, 1353 (Fed. Cir. 1998)). As plaintiff, Split Pivot bears the burden of proving infringement by a preponderance of the evidence. *Laitram Corp. v. Rexnord Inc.*, 939 F.2d 1533, 1535 (Fed. Cir. 1991). An infringement analysis involves two steps. First, the claim must be properly construed, as per the standards set forth above, to determine its scope and meaning. Second, the claim as properly construed must be compared to the accused device or process. *Absolute Software, Inc.*, 659 F.3d at 1129.

"Literal infringement requires that each and every limitation set forth in a claim appear in an accused product." *V-Formation, Inc. v. Benetton Grp. SpA*, 401 F.3d 1307, 1312 (Fed. Cir. 2005). "If any claim limitation is absent from the accused device, there is no literal infringement as a matter of law." *Bayer AG v. Elan Pharm. Research Corp.*, 212 F.3d 1241, 1247 (Fed. Cir. 2000).

A product that does not literally infringe may nevertheless infringe a patent under the doctrine of equivalents. "Infringement under the doctrine of equivalents requires that the accused product contain each limitation of the claim *or* its equivalent." *AquaTex Indus., Inc. v. Techniche Solutions*, 419 F.3d 1374, 1382 (Fed. Cir. 2005) (emphasis added). "An

element of an accused product is equivalent to a claim limitation if the differences between the two are insubstantial, a question that turns on whether the element of the accused product 'performs substantially the same function in substantially the same way to obtain the same result' as the claim limitation." *Absolute Software, Inc.*, 659 F.3d at 1139-40 (quoting *AquaTex Indus., Inc.*, 419 F.3d at 1382).

As previously noted, both literal infringement and infringement under the doctrine of equivalents are questions of fact. *Id.* at 1129-30. Summary judgment may nevertheless be appropriate "when no reasonable jury could find that every limitation recited in a properly construed claim either is or is not found in the accused device either literally or under the doctrine of equivalents." *U.S. Philips Corp. v. Iwasaki Elec. Co.*, 505 F.3d 1371, 1374-75 (Fed. Cir. 2007) (quoting *PC Connector Solutions LLC v. SmartDisk Corp.*, 406 F.3d 1359, 1364 (Fed. Cir. 2005)).

A. The '212 Patent

Split Pivot has moved for summary judgment on claim 22 of the '212 patent only. (Joint Summ. J. Charts (dkt. #190).) The accused products are the Trek Fuel EX and Superfly 100 bicycles. (*Id.*) Trek has moved for summary judgment of non-infringement on all asserted claims for all asserted Trek products. (*Id.*)

i. Literal Infringement

Literal infringement requires that each element of a claim be literally present in the accused product. If any element is missing, then Trek is entitled to summary judgment of no literal infringement as to that claim as a matter of law.

Based on this court's foregoing claims construction and the undisputed facts, neither the Fuel EX bicycles nor the Superfly 100 bicycles, to which Split Pivot's motion is limited, can literally infringe claim 22 of the '212 patent. The Fuel EX bicycles, which fall into the category of Full Floater products, indisputably have a shock absorber that is mounted to two links -- the control link and the wheel link -- as opposed to a shock absorber mounted to a single link selected from the listed Markush group. (*See* Reply to DPFOF (dkt. #178) ¶ 122.) Under this court's construction of the term, no reasonable jury could find that the Fuel EX bicycles literally include this element. Likewise, though the Superfly 100 bicycles do not have Full Floater, they cannot literally infringe because they have Fox RP2, Fox RP23, Fox RP3 or Fox CTD shocks, which are "air springs with internal fluid dampers." (Expert Report of Edward M. Caulfield (dkt. #139) ¶¶ 222.) Split Pivot's expert also states, more generally, that "[a]ll accused Trek models use shock absorbers which use either compressed gas or metal coil springs for the springing medium built around a body containing a fluid damper." (Expert Report of Tony Foale (dkt. #111) ¶ 275.) The parties thus agree that the shock absorbers on the Superfly 100 bicycles contain a combination of the elements in the patent's Markush group. Since the construction this court has adopted does not allow for combinations, the Superfly 100 bicycles cannot literally infringe claim 22.

In fact, given this court's construction of the Shock Absorber Element, and the fact that *all* Trek bicycles employ shock absorbers that feature a combination of a spring and fluid damper, Trek is entitled to summary judgment of no literal infringement on claims 1, 22 and 43, and all their asserted dependent claims, since all of these claims require a shock

absorber "selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid."

ii. Infringement under Doctrine of Equivalents

Split Pivot also asserts that the Fuel EX products and the Superfly 100 products infringe the '212 patent under the doctrine of equivalents. Under the doctrine of equivalents, a product may infringe a patent even if not every limitation is literally present. The question is "whether an omitted part is supplied by an equivalent device or instrumentality." *Deere & Co. v. Bush Hog, LLC*, 703 F.3d 1349, 1356 (Fed. Cir. 2012) (quoting *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, 520 U.S. 17, 32 (1997)). Under one test, a device is "equivalent" when it "matches the function, way, and result of the claimed element." *Id.* (quoting *Warner-Jenkinson*, 520 U.S. at 40). Alternatively, a device may be "equivalent" when the differences between the claimed element and that device are "insubstantial." *Warner-Jenkinson*, 520 U.S. at 40. "If no reasonable jury could find equivalence, then the court must grant summary judgment of no infringement under the doctrine of equivalents." *Id.*

Taking the Mounting Element first, Split Pivot relies on the function-way-result test and argues that "it is easily possible to achieve the same suspension performance as Trek alleges to possess in its 'fully floating' designs with a non-'fully floating' design." Foale, Split Pivot's expert, opined in his report that "for a given wheel displacement[,] the shock absorber displacement will be greater" when a shock absorber is fixed to the frame, rather than being mounted to two links in a "fully floating" design. (Expert Report of Tony Foale (dkt. #111) ¶ 198.) Foale went on to "create a non-floating design that gives suspension

characteristics that are for all practical purposes identical to the Trek floating designs" by (1) altering the 2013 Trek Fuel EX and 2012 Session, (2) changing the distance on the control link between the pivot and shock absorber mounting and (3) using a cloning feature to select a mounting location on the frame. (*Id.* at ¶¶ 197, 199.) The result of that redesign yields motion ratio curves that closely track one another.[19] (*See id.* Exh. X.) In essence, Split Pivot's argument is that Trek's Full Floater bicycles could achieve the same practical results with a non-Full Floater arrangement, if other features of their design were altered.

As Trek points out, however, "[t]he relevant question for this Court is not whether an infringing bike if redesigned could resemble Trek's bike. It is whether Trek's bike as designed performs the same function, in the same way, to achieve the same results as the limitation in claim 22." (Def.'s Resp. (dkt. #149) 39.) Split Pivot has not proposed any facts suggesting that Trek's Full Floater bicycles, with shock absorbers mounted to two links, achieve substantially the same results in substantially the same way as the suspension system *of the claimed invention*. Furthermore, Split Pivot's argument focuses entirely on the *results* the suspension system would yield: "[t]he fact that the two devices achieve substantially the same result creates no presumption that they do so in substantially the same way." *Universal Gym Equip. v. ERWA Exercise Equip.*, 827 F.2d 1542, 1548 (Fed. Cir. 1987). Split Pivot has proposed no facts that establish the way in which Full Floater products achieve those results, nor has it argued that the way Full Floater products achieve results is substantially the same as the way the bicycles of the claimed invention do. (*See* Pl.'s Mot. Summ. J. (dkt. #114) 28-29; Pl.'s Resp. (dkt. #153) 49-50; PPFF (dkt. #171) ¶¶ 68-71.)

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[19] "Motion ratio" is another term for "leverage ratio." ('301 Patent, 18:63-67.)

Summary judgment is the "'put up or shut up' moment in a lawsuit, when a party must show what evidence it has that would convince a trier of fact to accept its version of events." *Koszola v. Bd. of Educ. of City of Chi.*, 385 F.3d 1104, 1111 (7th Cir. 2004). Here, Split Pivot has generally alleged infringement on the basis of the doctrine of equivalents but has proposed *no* facts demonstrating that Trek's Full Floater arrangement achieves substantially the same results *in substantially the same way* as the suspension systems of the claimed invention. The only evidence offered is Foale's expert report, which contains only Foale's assertion that he could theoretically alter a Trek bicycle to yield the same suspension performance even without Full Floater.

Split Pivot has, therefore, "fail[ed] to make a showing sufficient to establish the existence of an element essential to [its] case, and on which [Split Pivot would] bear the burden of proof at trial." *Celotex Corp. v. Catrett*, 477 U.S. 317, 322 (1986). This "complete failure of proof" means that Trek is "entitled to a judgment as a matter of law." Accordingly, the court will therefore grant summary judgment of non-infringement for Trek on all Full Floater products, because no reasonable jury could find on the evidence provided that a shock absorber mounted to two links infringes the requirement of claims 1 and 22 of the '212 patent in the same way as one mounted to a single link selected from the Markush group.[20]

Next, the court considers whether, as Split Pivot contends, Trek's products infringe the Shock Absorber Element under the doctrine of equivalents. Split Pivot again relies on

[20] Even if Split Pivot had provided evidence of the similarities in the way Trek's shock absorbers are configured to that taught in the '212 patent, the court would be disinclined to stretch the doctrine of equivalents to reach beyond the obvious differences in a field so full of patents differentiated principally by the way essentially the same function is achieved.

Foale's report, in which he states that "[e]ach of the accused Trek models include[s] a shock absorber that provides both a spring force to absorb impact and facilitate suspension movement, and a damping capability to dissipate suspension movement or oscillation." (Expert Report of Tony Foale (dkt. #111) ¶ 213.) Foale goes on to state:

> By employing a gas spring or coil spring, in combination with a damping capability, the shock absorbers used on Trek's accused Evo-Link equipped bike models perform the same function, i.e., absorbing impact[s], supporting a load, and maintaining contact between the tyre and the ground), in the [same] way, i.e., through a combination of spring force and damping capabilities, to achieve the same result, i.e., impact absorption, load support and suspension facilitation, as the shock absorber claimed in claims 1, 22, and 43[,] which is made up of an element or elements from the group of compression gas springs, leaf springs, coil springs, and fluids.

(*Id.*; *see also id.* at ¶ 236 (incorporating by reference the above opinion in analyzing the non-Evo Link bicycles).)

Foale's report, and thus Split Pivot's argument, suffers from a critical flaw: Foale assumes, for the purposes of his doctrine of equivalents analysis, that Split Pivot's patents claim an invention in which a shock absorber may have "an element or *elements* from the group of compression gas springs, leaf springs, coil springs, and fluids." (*Id.* at ¶ 213.) His analysis distinguishes between the role of the spring and the role of the fluid dampener and states that Trek, in employing the two *in combination*, achieves the same thing in the same way as the shock absorber of the claims. The problem is that this court has construed the Shock Absorber Element to cover *only* embodiments in which the shock absorber is just *one* of the listed elements -- that is, either a spring *or* a fluid, but not both. Split Pivot has offered no evidence that Trek's bicycles include shock absorbers that achieve substantially the same results in substantially the same way as the single-element shock absorbers that its

patents claim. Indeed, Foale's report, with its emphasis on the *combination* of a spring and dampener to achieve the desired results, establishes the opposite is true.

Split Pivot has again neither produced any evidence suggesting that the difference between combination shock absorbers and single-element shock absorbers is "insubstantial," nor that they would accomplish substantially the same function in substantially the same way to achieve substantially the same result. To the contrary, the only evidence it has offered on that question suggests that combination shock absorbers make use of *both* elements in combination to achieve their function, which would make a single-element shock absorber *significantly* different. Given the dearth of evidence suggesting that the shock absorbers are not substantially different, the court finds that no reasonable jury could find equivalence on this record. Because *all* the asserted claims of the '212 patent include this element, and none of Trek's products includes either the literal element or an equivalent, Trek is entitled to summary judgment of non-infringement on every asserted claim. *See Kustom Signals, Inc.*, 264 F.3d at 1333 ("The all-elements rule is that an accused device must contain every claimed element of the invention or the equivalent of every claimed element.").[21]

B. The '301 Patent

Trek also moves for summary judgment of non-infringement on the '301 patent. Generally, identical or indisputably interchangeable terms in patents that share common ancestry should be construed consistently across the patents. *See AbTox, Inc. v. Exitron Corp.*,

[21] The court need not, therefore, reach the questions of whether Trek's products include, as properly construed, a "wheel link floating pivot," a brake link that "passes on two sides of a frame member," and force "transmitted through" the brake link.

131 F.3d 1009, 1010 (Fed. Cir. 1997) ("Although these claims have since issued in separate patents, it would be improper to construe this term differently in one patent than another, given their common ancestry."). While there can be exceptions, neither party has suggested it would be proper to construe any of the identical terms the '212 and '301 patents share differently across the two patents, and so the court will construe them consistently with one another. As a result, Trek is entitled to summary judgment of non-infringement based on the fact that its products do not infringe the Shock Absorber Element either literally or under the doctrine of equivalents.

Additionally, as the court noted above, the element "and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning 1/3 (third) and in the end 1/3 (third), and a change in slope value in the middle 1/3 (third)," which is present in each of the asserted claims of the '301 patent, excludes bicycles with suspension systems that have a zero slope in the first or last third of the leverage ratio curve. Similarly, bicycles that do not feature a change from negative to positive or positive to negative in the middle third of the leverage ratio curve would be excluded from this element of the asserted '301 claims.

The parties' experts have produced leverage ratio curves for Trek's accused bicycles that are nearly identical to one another, such that the infringement analysis under Trek's proposed construction is the same using either Caulfield's curve or Foale's curve. (*See* Expert Report of Edward M. Caulfield (dkt. #139) ¶¶ 69-70.) Foale's calculations appear in chart form, as organized by Split Pivot, below:

	First Third	Middle Third	Last Third
EX 2010	Negative	-0.0053 to -0.0035	Negative
EX 5 2010	Negative	-0.0050 to -0.0033	Negative
EX 7 2010	Negative	-0.0053 to -0.0035	Negative
EX 8-9.9 2010	Negative	-0.0043 to -0.0025	Both
EX 2013	Negative	-0.0029 to -0.0017	Both
EX 4 2013	Negative	-0.0055 to -0.0039	Negative
Top Fuel 8 2010	Negative	-0.0021 to -0.00034	Both
Session 2010	Negative	-0.0048 to -0.0036	Negative
Session 2012	Both	-0.0040 to -0.0029	Both
Session 88 2011	Both	-0.0042 to -0.0033	Both
Lush 2012	Negative	-0.0041 to -0.0022	Both
Lush 2013 29	Negative	-0.0042 to -0.0034	Negative
Remedy 2010	Negative	-0.0039 to -0.0019	Both
Scratch 2010	Both	-0.0032 to -0.0020	Both
Scratch Air 2010	Both	-0.0021 to -0.0011	Both
Slash 2012	Negative	-0.0038 to -0.0024	Both
Superfly 100 2010	Both	-0.00053 to -0.0040	Negative
Superfly 100 2013	Both	-0.0023 to -0.0028	Both
HiFi 2010	Both	-0.00056 to -0.0049	Negative
Rumblefish 2010	Both	-0.00028 to -0.0038	Negative
Rumblefish 2012	Both	-0.00046 to -0.0038	Negative

Roscoe 2009/10	Positive	0.00073 to -0.0019	Both
Roscoe 2012	Both	-0.0012 to -0.0023	Negative

Of the accused products, therefore, only the 2010 Roscoe meets the limitations as construed.[22] The EX 8-9.9 2010, EX 2013, Top Fuel 8 2010, Session 2012, Session 88 2911, Lush 2012, Remedy 2010, Scratch 2010, Scratch Air 2010, Slash 2012, Superfly 100 2010, Superfly 100 2013, HiFi 2010, Rumblefish 2010, Rumblefish 2012 and Roscoe 2012 all include negative, positive and zero slopes within the first and/or last thirds of the leverage ratio curve of the suspension system. Of those remaining, the EX 2010, EX 5 2010, EX 7 2010, EX 4 2013, Session 2010 and Lush 2013 29 all fail to include a "change in slope value" in the middle third of the leverage ratio curve.

The Leverage Ratio Curve Element also appears in every allegedly infringed claim of the '301 patent. Split Pivot's only argument regarding those claims was dependent on this court adopting its construction of that element. Since the court has in fact adopted Trek's construction, none of the accused Trek products can literally infringe the '301 patent as a matter of law, with the possible exception of the 2010 Roscoe. Thus, subject to that exception, Trek is entitled to summary judgment on these grounds as well.[23]

[22] Trek appears to have conceded that the 2010 Roscoe contains the Leverage Ratio Curve Element under the court's (and its own) construction. The court is not clear as to why this is, given that the chart lists the Roscoe 2009/10 as having both a positive and negative slope in the final third of the leverage ratio curve, which would necessitate a zero slope when the curve changes from positive to negative or negative to positive. The court will, however, defer to the parties on this question.

[23] Split Pivot does not argue that the Trek products have the leverage ratio curve element under the doctrine of equivalents.

IV. Invalidity and Willful Infringement

Patents are presumed to be valid. 35 U.S.C. § 282. Invalidity of the patent or any claim in suit may, however, be raised as a defense in an action involving patent infringement. *Id.* "[A] moving party seeking to invalidate a patent at summary judgment must submit such clear and convincing evidence of facts underlying invalidity that no reasonable jury could find otherwise." *TriMed, Inc. v. Stryker Corp.*, 608 F.3d 1333, 1340 (Fed. Cir. 2010); *see also Microsoft Corp. v. i4i Ltd. P'ship*, 131 S. Ct. 2238, 2251 (2011) (reaffirming the "clear and convincing" standard of proof").

Trek has moved for summary judgment on the basis of invalidity for various claims of the '212 patent based on insufficient written description, pursuant to 35 U.S.C. § 112. Trek also argues that the asserted claims of the '301 patent are invalid as anticipated by Trek's own 2008 Trek Fuel EX under 35 U.S.C. § 102. The Court of Appeals for the Federal Circuit has held that a district court has the discretion to dismiss invalidity counterclaims upon a grant of summary judgment of non-infringement. *Phonometrics, Inc. v. Northern Telecom Inc.*, 133 F.3d 1459, 1468 (Fed. Cir. 1998); *Cardinal Chemical Co. v. Morton Int'l, Inc.*, 508 U.S. 83, 95 (1993) (in addressing motion for declaratory judgment district court has discretion to decide whether to exercise jurisdiction even when established). Exercising this discretion is particularly appropriate when non-infringement is clear and invalidity is not plainly evident. *Phonometrics, Inc.*, 133 F.3d at 1468 (citing *Leesona Corp. v. United States*, 530 F.2d 896, 906 n.9 (Ct. Cl. 1976)).

Here, the court has found as a matter of law that Trek has not infringed any of the asserted claims of the '212 and '301 patents. Accordingly, the court will exercise its discretion to dismiss Trek's invalidity counterclaims without prejudice at this time.

Finally, Trek also seeks summary judgment as to Split Pivot's claim of *willful* infringement. Under 35 U.S.C. § 284, a court may increase the damages assessed for infringement by "up to three times the amount found or assessed." Though the statute itself does not provide any standard for awarding such enhanced damages, the Federal Circuit has held that "an award of enhanced damages requires a showing of willful infringement." *In re Seagate Tech., LLC*, 497 F.3d 1360, 1368 (Fed. Cir. 2007). To establish willful infringement, "a patentee must show by clear and convincing evidence that the infringer acted despite an objectively high likelihood that its actions constituted infringement of a valid patent." *Id.* at 1371. Since willful infringement requires an underlying finding of infringement, Trek is also entitled to summary judgment on Split Pivot's claim of willful infringement.

Accordingly,

ORDER

IT IS ORDERED that:

1) plaintiff Split Pivot's motion for summary judgment of infringement (dkt. #113) is DENIED;

2) defendant Trek's motion for summary judgment of non-infringement and no willful infringement (dkt. #124) is GRANTED;

3) defendant Trek's motion for summary judgment of invalidation (dkt. #124) is DENIED and Trek's invalidity counterclaims are DISMISSED without prejudice; and

4) the parties' stipulation for dismissal of counts 3 and 4 of the first amended complaint (dkt. #199) is GRANTED and the clerk of court shall enter judgment as set forth above and close the case.

Entered this 13th day of December, 2013.

BY THE COURT:

/s/

WILLIAM M. CONLEY
District Judge

US007717212B2

(12) United States Patent
Weagle

(10) **Patent No.:** **US 7,717,212 B2**
(45) **Date of Patent:** **May 18, 2010**

(54) **VEHICLE SUSPENSION SYSTEMS FOR SEPERATED ACCELERATION RESPONSES**

(75) Inventor: **David Weagle**, Edgartown, MA (US)

(73) Assignee: **Split Pivot, Inc.**, Edgartown, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 437 days.

(21) Appl. No.: **11/510,522**

(22) Filed: **Aug. 25, 2006**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
B62D 61/02 (2006.01)

(52) **U.S. Cl.** **180/227**; 280/283; 280/284; 280/285; 280/286; 280/288

(58) **Field of Classification Search** 180/227; 280/284, 283, 285, 286, 288
See application file for complete search history.

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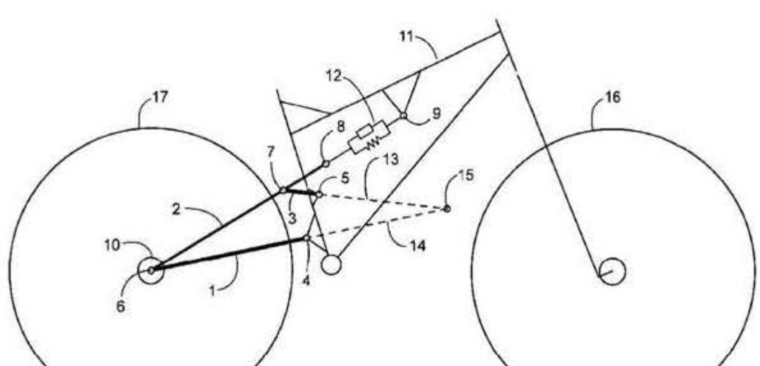
Primary Examiner—Lesley Morris
Assistant Examiner—Maurice Williams
(74) *Attorney, Agent, or Firm*—Stahl Law Firm

(57) **ABSTRACT**

The invention relates to suspension systems comprising, in certain embodiments, a pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by placement of an instant force center, and so that acceleration forces can be controlled by a swinging wheel link.

64 Claims, 7 Drawing Sheets



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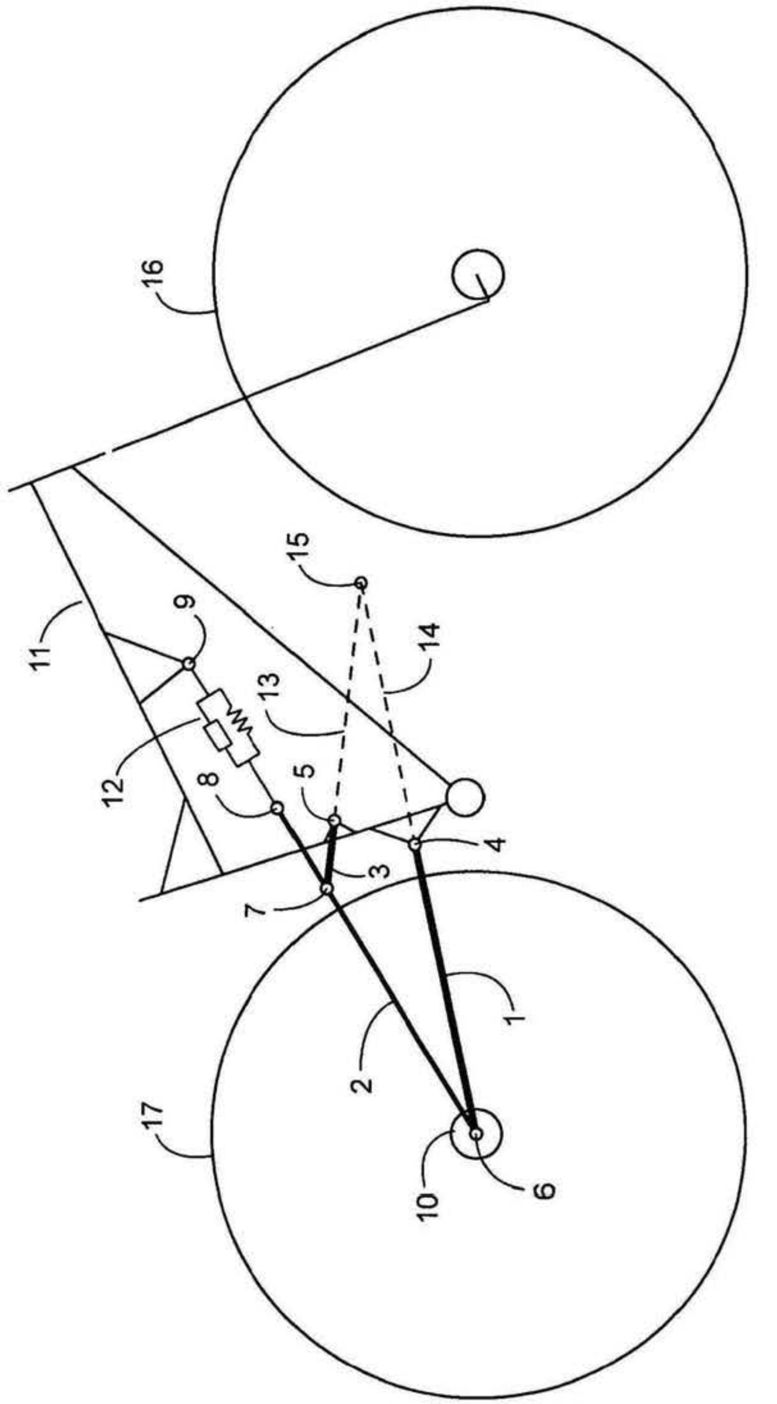

FIGURE 1

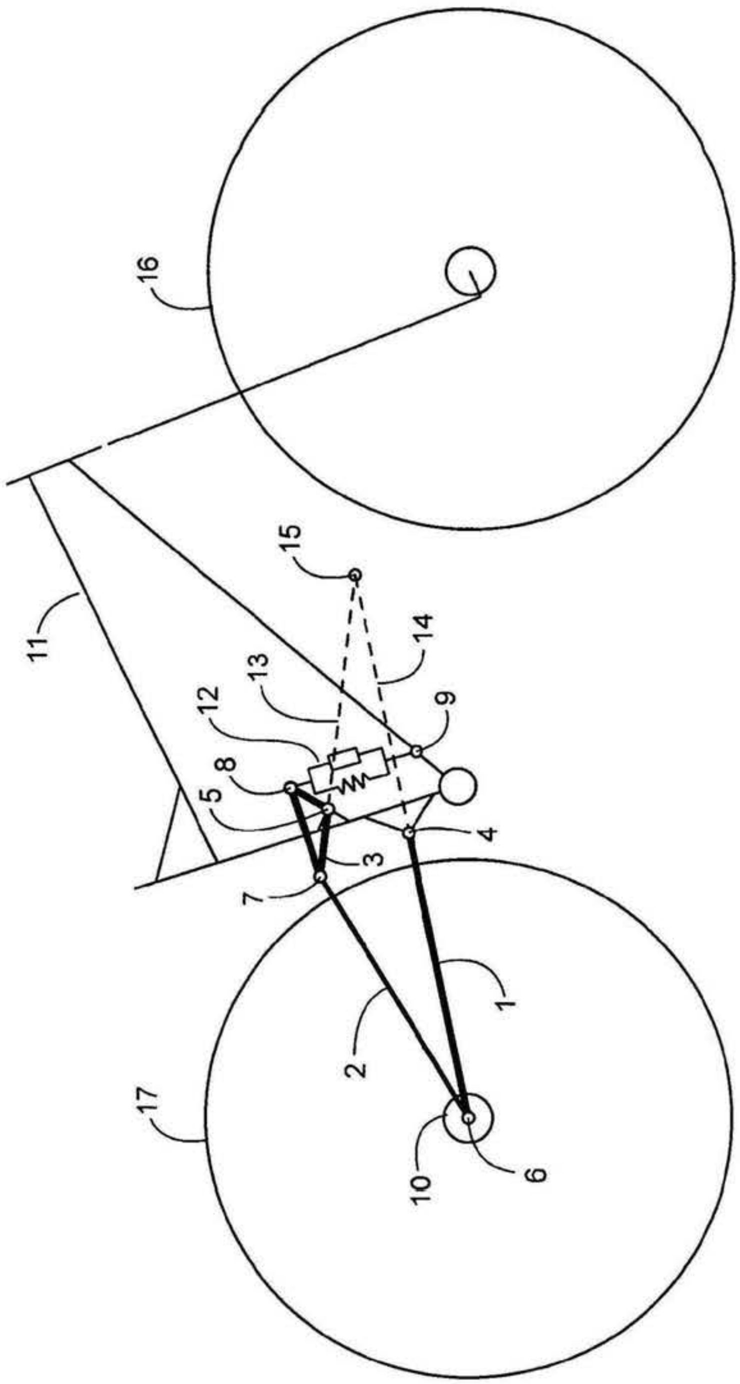

FIGURE 2

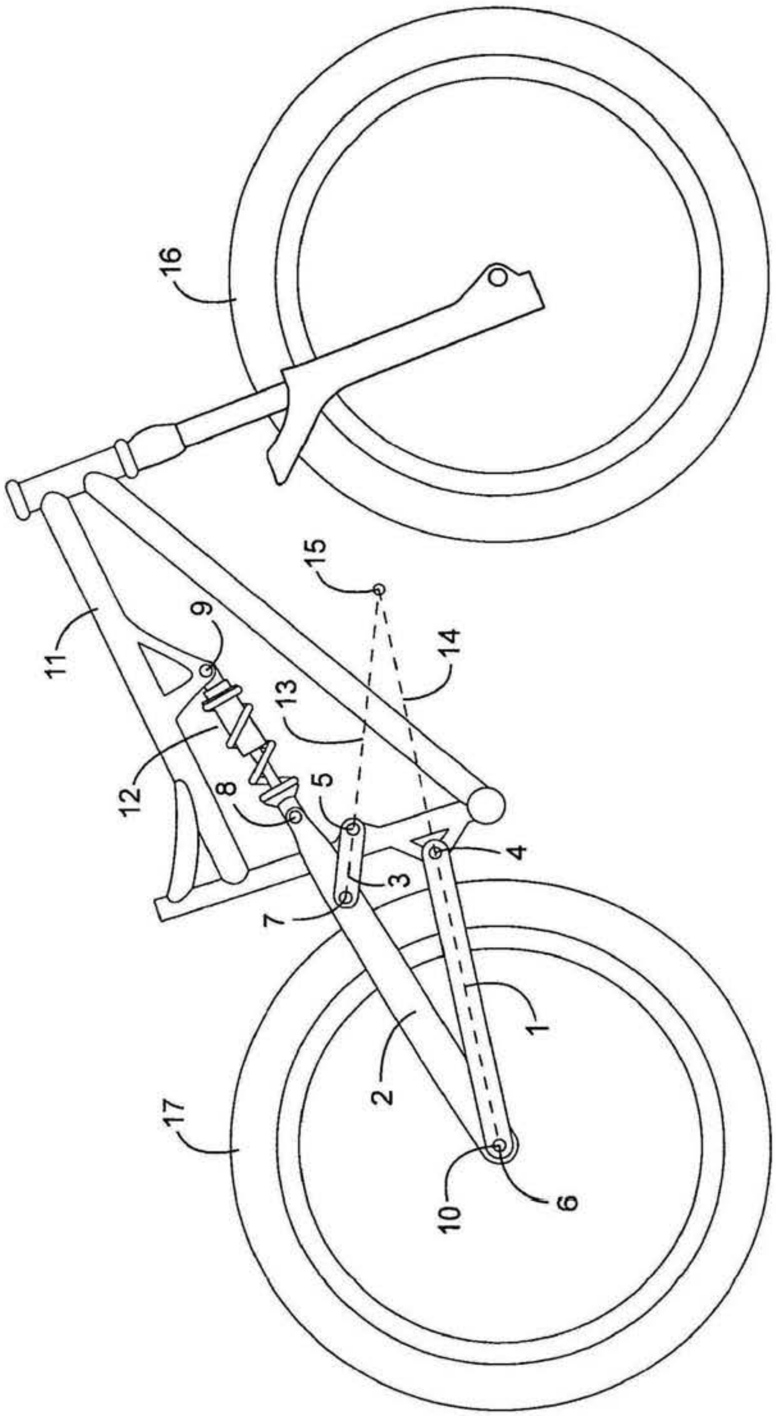

FIGURE 3

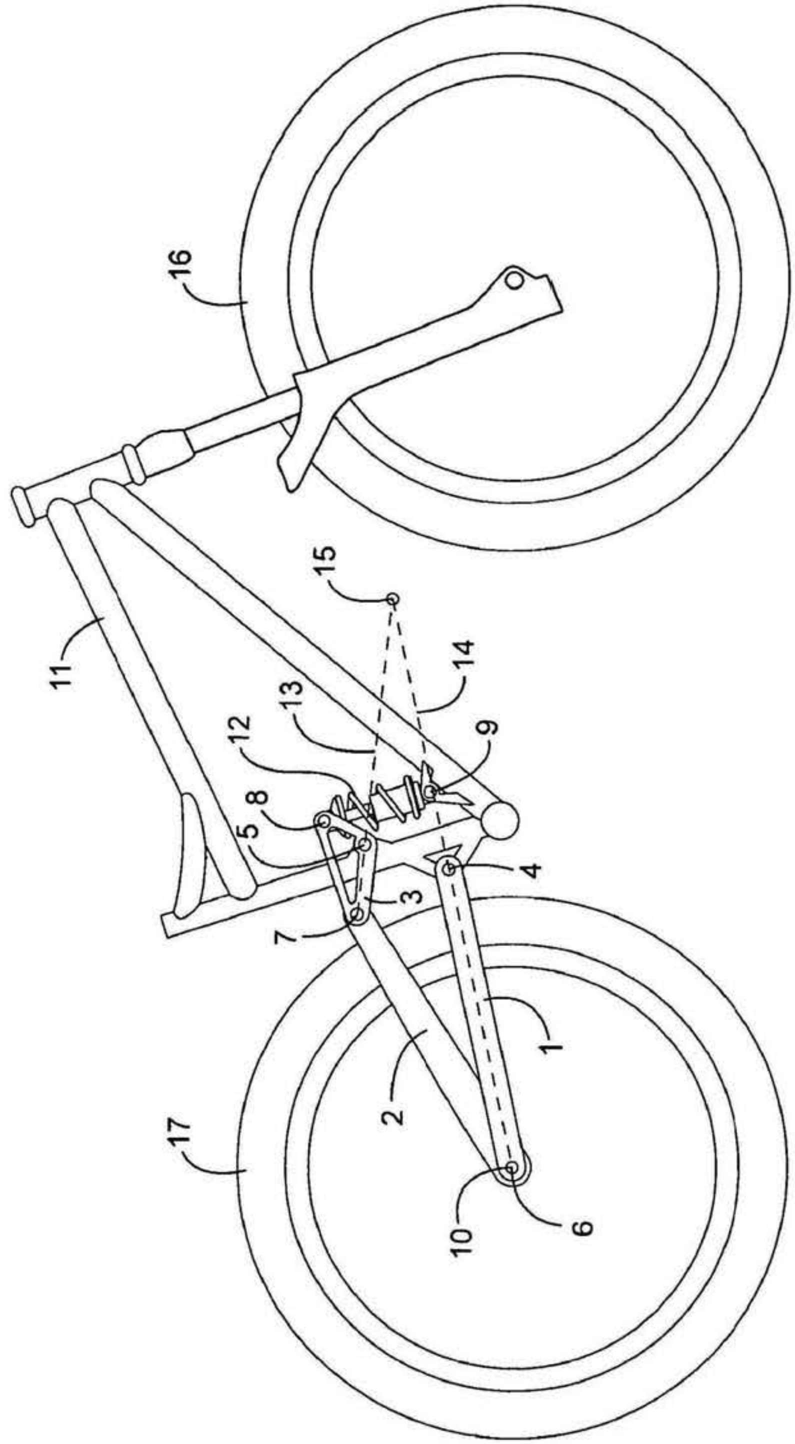

FIGURE 4

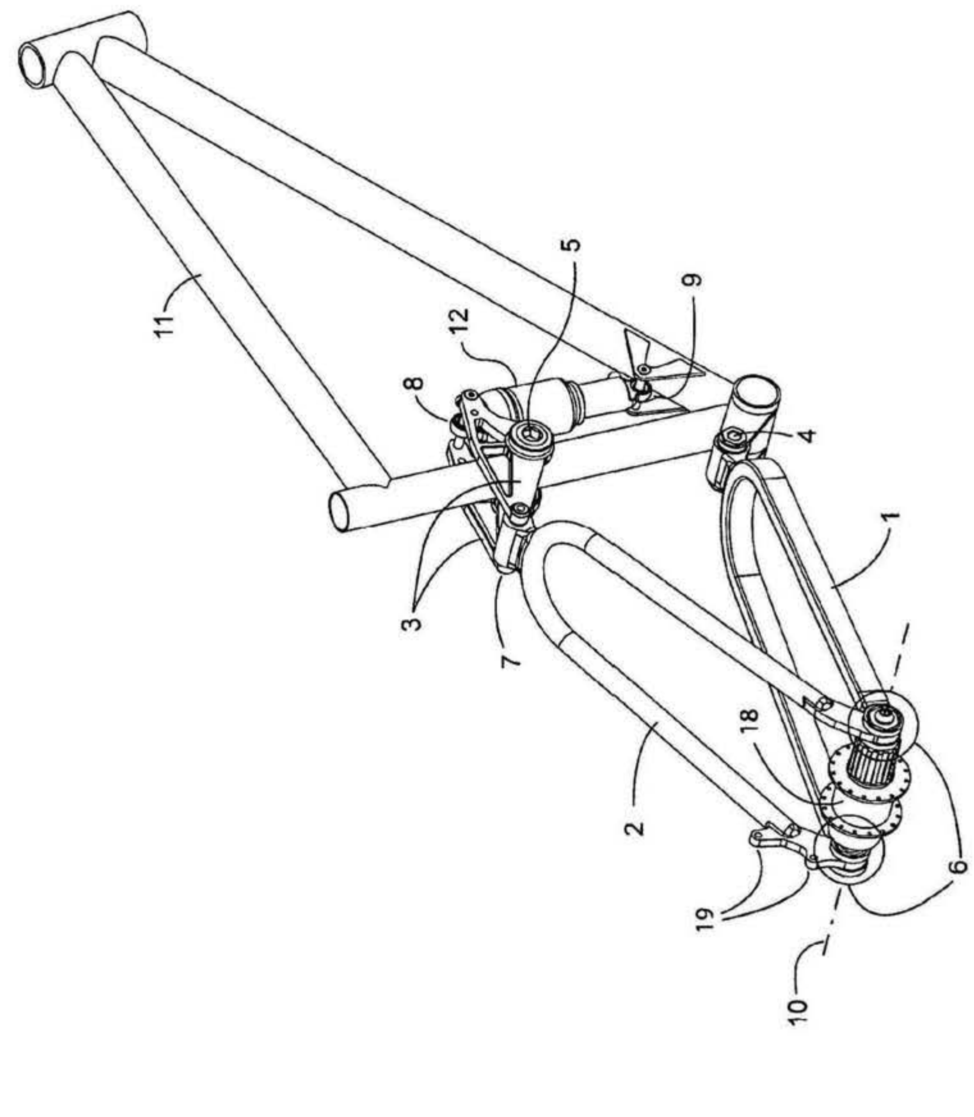

FIGURE 5

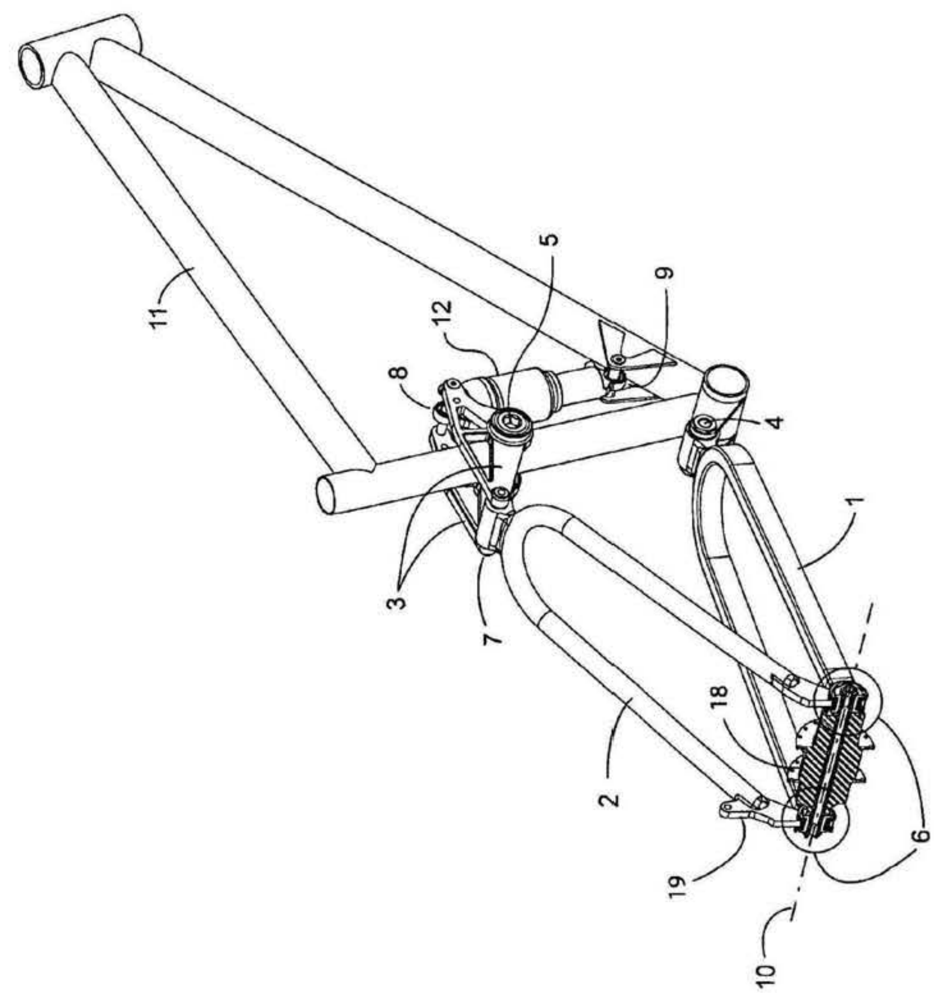

FIGURE 6

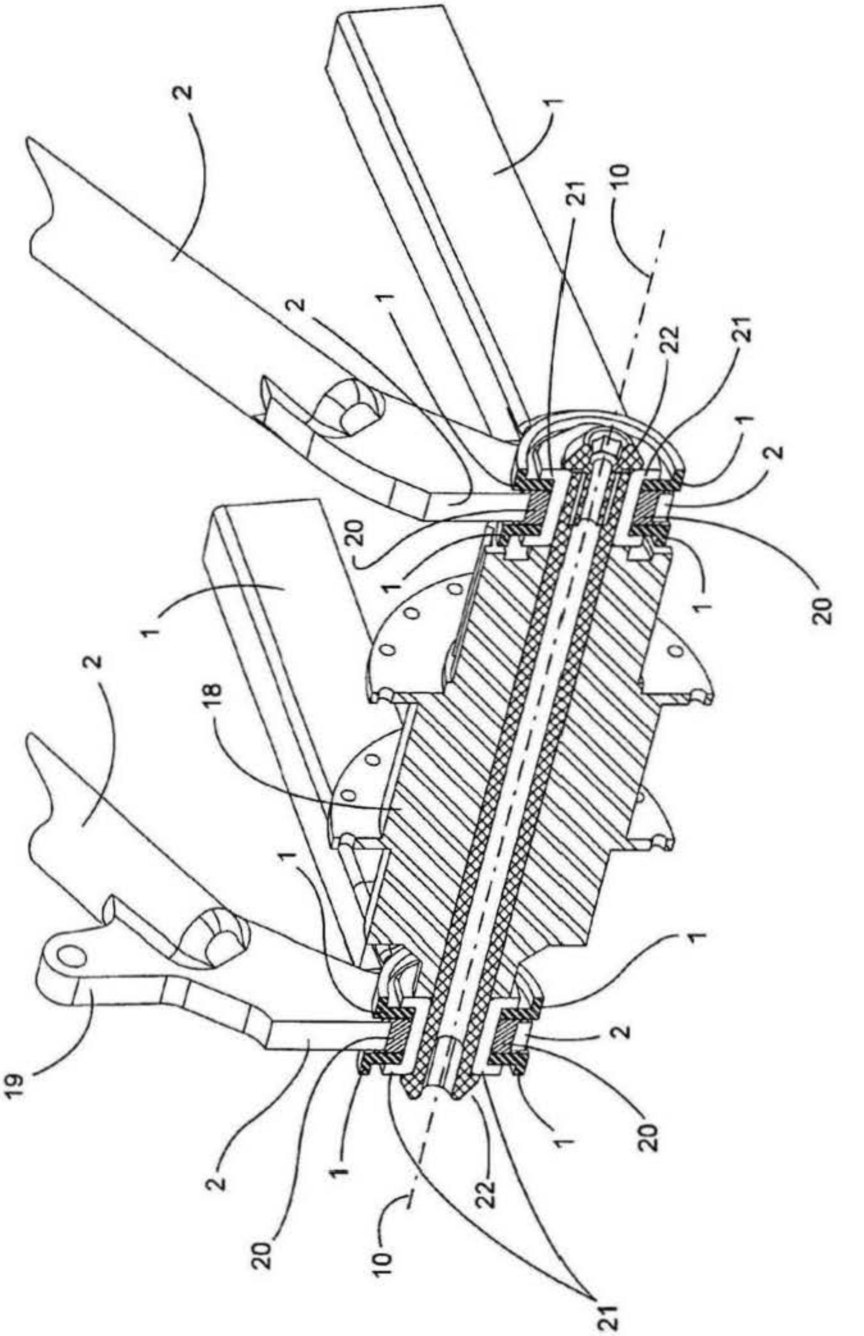

FIGURE 7

VEHICLE SUSPENSION SYSTEMS FOR SEPERATED ACCELERATION RESPONSES

1.0 FIELD OF THE INVENTION

This invention relates to suspension systems capable of separating acceleration responses.

2.0 BACKGROUND

Automobiles, bicycles, motorcycles, all terrain vehicles, and other wheel driven vehicles are used for various purposes, including transportation and leisure. These vehicles are designed to use a power source to drive through a power transmission system to a wheel or wheels, which transfers rotary motion to the ground via tractive force between a wheel or wheels and the ground. Vehicles are also used to traverse even terrain like paved streets, and uneven terrain like off-road dirt trails. Off road trails are generally bumpier and allow for less wheel traction than paved roads. A bumpier terrain is best navigated with a vehicle that has a suspension system. A suspension system in a vehicle is aimed to provide a smoother ride for an operator or rider, and increase wheel traction over varied terrain. Vehicle suspension systems for the front wheel and for the back wheel are available. These vehicles have means of powered acceleration and deceleration. Powered acceleration can be achieved through machine or human power rotating a wheel through a mechanical arrangement. Deceleration can be achieved through the use of a braking system that mechanically impedes rotation of a wheel.

One undesirable effect of suspension systems is unwanted responses or suspension compression or extension during powered acceleration or deceleration. Acceleration and deceleration forces cause a suspension system to react in different ways. It is beneficial to rider comfort for a suspension to be designed to specifically recognize and respond to differing acceleration and deceleration forces. Complex systems using linkages or hydraulic means exist to reduce unwanted suspension movement that occurs during acceleration or deceleration. The drawback to these other systems is their complexity and associated cost. With more complex designs, more expensive manufacturing techniques are required to build them. Less complex systems are more cost effective, but do not allow for the separation of acceleration forces under powered acceleration and braking, which reduces suspension effectiveness, but allows a lower overall cost.

A need exists for suspension systems that can provide separated acceleration and deceleration responses while remaining cost effective to produce. The present invention provides new suspension systems for vehicles that can provide separated acceleration responses and that are cost effective.

3.0 SUMMARY OF THE INVENTION

The current invention relates to new suspension systems for vehicles, for example, bicycles, motorcycles, cars, SUVs, trucks, two wheel vehicles, four wheel vehicles, front wheel suspension vehicles, driven wheel suspension vehicles, and any other kind of vehicle with a suspension system. In certain embodiments of the invention, a suspension system of the invention can support a wheel using a link arrangement to control suspension movement by manipulating braking forces present in the links during deceleration.

Suspension systems of the invention are useful for a variety of vehicles and preferably in human powered vehicles. Unwanted suspension movement can have a significant detrimental effect on rider performance and comfort. The need for a suspension system that can control suspension movement under acceleration and deceleration has therefore become more pressing. The present invention provides suspension system designs for vehicles that reduce unwanted suspension movements during acceleration and deceleration.

Certain embodiments of the invention can comprise a wheel suspension system where a wheel is connected to a wheel link. In certain embodiments, a braking arrangement intended to impede wheel rotation when needed is attached to a brake link. The brake link, in certain embodiments, may be attached to the wheel link through a pivoting or flexing connection concentric to the wheel rotation axis, and attached at another point through a pivoting or flexing connection to a control link. The brake link, in certain embodiments, can be attached to the wheel link through a pivoting and/or flexing connection, and in certain other embodiments the brake link is attached at another point through a pivoting and/or flexing connection to a control link. The control link and wheel link, in certain embodiments, each have a link force line. A link force line of a control link and a wheel link, in certain embodiments, intersect in a point called instant force center. The location of this instant force center, in certain embodiments, governs suspension reaction to deceleration as a result of braking.

Certain embodiments of the invention can comprise a shock absorber. A shock absorber, in certain embodiments, may be a damper, a spring, a compression gas spring, a leaf spring, a coil spring, or a fluid. In certain other embodiments, a shock absorber is mounted so that it is able to respond to movement of a rear wheel. In certain embodiments, a shock absorber is mounted to a brake link. In certain embodiments, a shock absorber is mounted to a control link. In certain embodiments, a shock absorber is mounted to a brake link and/or a control link in a pivotal manner, and preferably so that a force that compresses or extends the shock absorber is transmitted through a brake link or a control link.

4.0 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. **2** shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. **3** shows a side view of a bicycle using the wheel suspension system shown in FIG. **1**.

FIG. **4** shows a side view of a bicycle using the wheel suspension system shown in FIG. **2**.

FIG. **5** shows a three dimensional view of a bicycle using the wheel suspension system shown in FIG. **2** and FIG. **4**.

FIG. **6** shows a three dimensional view of a bicycle using the wheel suspension system shown in FIG. **2**, FIG. **4**, and FIG. **5**, with a cutaway view of a critical area.

FIG. **7** shows a three dimensional cutaway view of a wheel link pivot of a bicycle using the wheel suspension system shown in FIG. **2**, FIG. **4**, FIG. **5**, and FIG. **6**, with a cutaway view of a critical area according to certain embodiments of the invention.

5.0 DETAILED DESCRIPTION

Vehicles must be accelerated against their environment to propel an operator or rider across terrain. In order to acceler-

ate these vehicles, a certain amount of energy must be exerted and transformed into rotary motion at a wheel or plurality of wheels. Suspended wheeled vehicle energy conversion types are widely varied. Some vehicles like bicycles, tricycles, and pedal cars use converted human energy as the drive unit. Other vehicles use electric motors or combustion engines, as their drive unit. These electric motors and combustion engines extract rotary motion through the controlled release of chemically stored energy.

Almost all vehicle types use some sort of rotary motion transmission system to transfer rotational force from a drive unit to a wheel or plurality of wheels. A simple bicycle or motorcycle or all terrain vehicle uses a chain or belt to transfer power from a drive unit to a wheel. These chain or belt drive transmissions typically use one sprocket in the front which is coupled to a drive system and one sprocket in the rear which is coupled to a wheel.

More complex bicycles, motorcycles, all terrain vehicles, and automobiles use a shaft drive system to transfer power from a drive system to a driven wheel or wheels. These shaft drive systems transfer power through a rotating shaft that is usually reasonably perpendicular to the driven wheel spinning axis, with power transferred to the driven wheel via a bevel, spiral bevel, hypoid, worm gear drivetrain, or some other means. These single sprocket chain and belt, and shaft driven vehicles can use a direct driven single speed arrangement, where drive unit output shaft speed and torque is transferred to the driven wheel at a constant unchanging ratio. These single sprocket chain and belt, and shaft driven vehicles can also use a commonly found multi speed arrangement, where drive unit output shaft speed and torque is transferred to the driven wheel at a variable ratio through operator selected or automatically selected ratio changing mechanisms.

A bicycle with a more advanced design includes gear changing systems that have clusters of selectable front chainrings and rear sprockets. These gear changing systems give the bicycle rider a selectable mechanical advantage for use during powered acceleration. The mechanical advantage selection, allows a rider spinning a front sprocket cluster via crank arms, to attain lower revolution speed and higher torque values, or conversely, higher revolution speed and lower torque values at a driven wheel.

The current invention, in certain embodiments, is directed at suspension systems for vehicles that can reduce unwanted suspension movement during braking deceleration, for example, a bicycle, a motorcycle, a car, an SUV, a truck, or any other kind of vehicle. Suspension systems of the current invention are useful for a large variety of vehicles, including, but not limited to, human powered vehicles, off road use vehicles with long displacement suspension, high efficiency road going vehicles, and other vehicles.

A vehicle suspension system isolates a vehicle chassis from forces imparted on the vehicle when traversing terrain by allowing the vehicle's ground contact points to move away from impacts at the terrain level and in relation to the vehicle chassis by a compressible suspension movement. The compressible suspension movement that isolates a chassis from these impacts is called suspension displacement or suspension travel. Compressible suspension travel has a beginning point where the suspension is in a completely uncompressed state (the suspension is uncompressed), and an ending point of displacement, where the suspension is in a completely compressed state (the suspension is fully compressed). Suspension travel displacement is measured in a direction parallel to and against gravity. As a suspension system using certain embodiments the invention is compressed, a shock

absorber is compressed. As the shock absorber is compressed, the force output from the unit rises. Pivots of a suspension system of the invention are named after a component that connects with the pivot. A pivot may be fixed or floating. A fixed pivot maintains a position relative to the frame of the vehicle when the suspension is compressed. A floating pivot changes its position relative to the frame of the vehicle when the suspension is compressed. A suspended wheel has a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place. At the beginning of the wheel suspension travel distance, when the suspension is in a completely uncompressed state, the shock absorber is in a state of least compression, and the suspension is easily compressed. As the suspended wheel moves compressively, shock absorber force at the wheel changes in relation to shock absorber force multiplied by a leverage ratio, where a leverage ratio is the ratio of compressive wheel travel divided by shock absorber compression over an identical given wheel travel distance.

5.1 The Drawings Illustrate Examples of Certain Embodiments of the Invention

The Figures in this disclosure use the following numbers and terms; wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**); rear hub (**18**); brake mount (**19**); pivot bearing (**20**); pivot axle (**21**); thru axle (**22**)

FIG. **1** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **1** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **1**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **1**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to

the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The brake link **2** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **2** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **2** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **2**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **2**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and

wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The control link **3** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **3** presents a design as shown in FIG. **1** for a suspension according to certain embodiments of the current invention via a two-dimensional side view. FIG. **3** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **3** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**).

FIG. **4** presents a design as shown in FIG. **2** for a suspension according to certain embodiments of the current invention via a two-dimensional side view. FIG. **4** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **4** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**).

FIG. **5** presents a design as shown in FIG. **2** and FIG. **4** for a suspension according to certain embodiments of the current invention via a three-dimensional view. FIG. **5** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **5** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); rear hub (**18**); brake mount (**19**). A frame **11** provides the structure for the vehicle. The frame **11** depicts a tubular structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting

location which allows for wheel link **1** articulation in at least one degree of freedom. In the embodiment presented in FIG. **5**, the wheel link fixed pivot **4** comprises a clevis that is a structural component of the frame **11**, and a hitch to be received by the clevis, where the hitch is a structural component of the wheel link **1**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. The rear hub **18** is a structural component of the rear wheel **17** shown in FIGS. **1**, **2**, **3**, and **4**. The rear hub **17** and rear wheel **17** share a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. In the embodiment presented in FIG. **5**, the wheel link floating pivot **6** comprises a pair of clevis that is are structural components of wheel link **1**, and a pair of hitches to be received by the clevises, where the hitches are structural components of the brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. In the embodiment presented in FIG. **5**, a disc brake caliper can be bolted to a brake mount **19**. The disc brake caliper will clamp on a disc brake rotor that is attached to the rear hub so that braking force can travel through the hub, through spokes or a wheel, to a tire and be transferred to the ground. Another design for the brake system is to use cantilever brakes or V-Brakes, where the brakes are mounted to the brake link **2** via posts that project from the brake link. The cantilever brakes or V-brakes then use a pad that can be clamped onto the wheel and slow the wheel down. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. In the embodiment presented in FIG. **5**, the control link **3** is shown as two separate parts that together control the brake link **2** movements. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The control link **3** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**.

FIG. **6** presents a design as shown in FIG. **2**, **4**, and FIG. **5** for a suspension according to certain embodiments of the current invention via a three-dimensional view. FIG. **6** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **6** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); rear hub (**18**); brake mount (**19**). A cutaway view of the rear hub **18** and wheel link floating pivot **6** is shown for locational purposes for reference when viewing FIG. **7**.

FIG. **7** shows a three-dimensional cutaway view of a wheel link floating pivot **6** as shown in FIG. **2**, **4**, **5** and FIG. **6** for a suspension according to certain embodiments of the current invention. FIG. **7** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **7** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel rotation axis (**10**); rear hub (**18**); brake mount (**19**); pivot bearing (**20**); pivot axle (**21**); thru axle (**22**). Certain embodiments of the wheel link floating pivot **6** can comprise a pivot bearing **20**, which allows for the independent rotation of the brake link **2** and wheel link **1** around a hub rotation axis **10**. The rotation of the wheel link **1** and brake link **2** can be concentric to the hub rotation axis **10**. A pivot bearing **20** can be a singular or multiple of a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a flexure, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. A pivot axle **21** acts as a bearing surface for the pivot bearing **20**. The pivot axle **21** can comprise singular or multiple parts. The pivot axle **21** can have a hole through it where it can receive a thru axle **22**. The thru axle **22** can comprise singular or multiple parts. The thru axle **22** can be used to mount the rear hub **18** concentric to the wheel link floating pivot **6**, yet still allow removal of the rear hub **18** for convenience. A thru axle **22** can comprise a solid axle, a thru axle, a hollow axle, a QR, a quick release, a skewer, a quick release skewer, a through bolt, or other components intended to allow rear hub **18** rotation around a wheel rotation axis **10**. The rear hub **18** is shown as a solid part for simplicity of illustration, where in reality it rotates on ball bearings that allow independent rotation of the rear hub **18** and rear wheel in relation to the thru axle **22** and concentric to the wheel rotation axis **10**. A disc brake rotor can be attached to the rear hub **18** so that braking force can travel through the rear hub **18**, through spokes and or a wheel, to a tire and be transferred to the ground.

5.2 Wheel Links of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link, or two, three, four, five or more wheel links. A wheel link, in certain embodiments, is connected to a wheel link floating pivot and/or a wheel link fixed pivot. In certain embodiments, a wheel link is located below (in other words, closer to the ground than) a brake link, a control link floating pivot, a control link, a first shock pivot, a shock absorber, an instant force center and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a suspension system of the invention comprises a wheel link that is the same length or about the same length as a brake link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a wheel link that is 5 percent or about 5 percent longer or shorter than a brake link of that suspension system, or 10 percent or about 10 percent longer or shorter, or 20 percent or about 20 percent longer or shorter, or 30 percent or about 30 percent longer or shorter, or 5 to 20 percent longer or shorter, or 5 to 50 percent longer or shorter, or 5 to 100 percent longer or shorter, or 5 to 200 percent longer or shorter, or 5 to 500 percent longer or shorter. In certain other embodiments, a wheel link of the invention is 2 to 50 centimeters (cm) in length, or 30 to 45 cm, or 35 to 40 cm. In certain other embodiments, a suspension system of the invention comprises a wheel link that is the same diameter or about the same diameter as a brake link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a wheel link that is 5 percent or about 5 percent larger or smaller in diameter than a brake link of that suspension system, or 10 percent or about 10 percent larger or

smaller in diameter, or 20 percent or about 20 percent larger or smaller in diameter, or 30 percent or about 30 percent larger or smaller in diameter, or 5 to 20 percent larger or smaller in diameter. In certain other embodiments, a wheel link of the invention is 0.5 to 5 cm in diameter, or 1 to 4 cm, or 1.5 to 3 cm, or 2 to 2.5 cm.

5.3 Brake Links of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a brake link, or two, three, four, five or more brake links. A brake link, in certain embodiments, is connected to a wheel link floating pivot, a control link floating pivot and/or a first shock pivot. In certain embodiments, a brake link is located above (in other words, further from the ground than) a wheel link of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a brake link is located below (in other words, closer to the ground than) a control link floating pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a suspension system of the invention comprises a brake link that is the same length or about the same length as a wheel link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a brake link that is 5 percent or about 5 percent longer or shorter than a wheel link of that suspension system, or 10 percent or about 10 percent longer or shorter, or 20 percent or about 20 percent longer or shorter, or 30 percent or about 30 percent longer or shorter, or 5 to 20 percent longer or shorter, or 5 to 50 percent longer or shorter, or 5 to 100 percent longer or shorter, or 5 to 200 percent longer or shorter, or 5 to 500 percent longer or shorter. In certain other embodiments, a brake link of the invention is 2 to 100 cm in length, or 35 to 55 cm, or 40 to 50 cm. In certain other embodiments, a suspension system of the invention comprises a brake link that is the same diameter or about the same diameter as a wheel link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a brake link that is 5 percent or about 5 percent larger or smaller in diameter than a wheel link of that suspension system, or 10 percent or about 10 percent larger or smaller in diameter, or 20 percent or about 20 percent larger or smaller in diameter, or 30 percent or about 30 percent larger or smaller in diameter, or 5 to 20 percent larger or smaller in diameter. In certain other embodiments, a brake link of the invention is 0.5 to 5 cm in diameter, or 1 to 4 cm, or 1.5 to 3 cm, or 2 to 2.5 cm.

In certain other embodiments, a brake link and a wheel link of a suspension system of the invention are arranged relative to each other in a non-parallel manner when observed from side of the vehicle comprising the suspension system. In certain embodiments, a brake link and a wheel link are arranged relative to each other at an angle of 0 to 150 degrees, or 0 to 100 degrees, or 0 to 80 degrees, or 10 to 60 degrees, or 15 to 40 degrees, or 20 to 30 degrees, when observed from the side of the vehicle, while the suspension of said vehicle is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a brake link passes on a side of a frame member or on two sides of a frame member.

5.4 Control Links of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link, or two, three, four, five or more control links. A control link of a suspension system of the invention, in certain embodiments, is connected to a brake link. In certain other embodiments, a control link is connected to a control link floating pivot, a brake link and/or a control link fixed pivot. In certain other embodiments, a control link passes on a side of a frame member or on two sides of a frame member. In certain embodiments, a control link is located above a wheel link, a wheel link floating pivot, a wheel link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link fixed pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a control link is located below a control link floating pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link of the invention is 0.5 to 5 cm in diameter, or 1 to 4 cm, or 1.5 to 3 cm, or 2 to 2.5 cm. In certain other embodiments, a suspension system of the invention comprises a control link with a length that is 2 percent or about 2 percent of the length of a wheel link of that suspension system, or 5 percent or about 5 percent longer or shorter, or 10 percent or about 10 percent longer or shorter, or 20 percent or about 20 percent longer or shorter, or 30 percent or about 30 percent longer or shorter, or 2 to 20 percent longer or shorter, or 2 to 50 percent longer or shorter, or 2 to 100 percent longer or shorter, or 2 to 200 percent longer or shorter, or 2 to 500 percent longer or shorter. In certain other embodiments, a control link of the invention is 1 to 50 cm in length, or 2 to 25 cm, or 8 to 15 cm.

5.5 Wheel Link Fixed Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link fixed pivot, or two, three, four, five or more wheel link fixed pivots. In certain embodiments, a wheel link fixed pivot of a suspension system of the invention is located below a control link floating pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link, a control link fixed pivot, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a wheel link fixed pivot of a suspension system of the invention is located above a second shock pivot, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.6 Control Link Fixed Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link fixed pivot, or two, three, four, five or more control link fixed pivots. In certain embodiments, a control link fixed pivot of a suspension system of the invention is located below a control link floating pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In

certain embodiments, a control link fixed pivot of a suspension system of the invention is located above a second shock pivot, a wheel link floating pivot, a wheel link fixed pivot, a wheel link, a brake link, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.7 Wheel Link Floating Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link floating pivot, or two, three, four, five or more wheel link floating pivots. In certain embodiments, a wheel link floating pivot of a suspension system of the invention is concentric with a wheel rotation axis of the vehicle, preferably the wheel rotation axis of a driven wheel, a rear wheel, a front wheel, or a suspended wheel of the vehicle. In certain other embodiments, a wheel link floating pivot is nearly concentric with a wheel rotation axis of the vehicle, preferably the wheel rotation axis of a driven wheel, a rear wheel, a front wheel, or a suspended wheel of the vehicle. A wheel link floating pivot is nearly concentric with a wheel rotation axis if the axis the pivot turns around is within 2 cm of the wheel rotation axis, or within 5 cm, or within 10 cm, or within 15 cm, or when the wheel axis and pivot axis are from 2 to 20 cm away from each other, or from 5 to 15 cm, or from 5 to 10 cm.

In certain embodiments, a wheel link floating pivot of a suspension system of the invention is located below a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a wheel link floating pivot of a suspension system of the invention is located above a wheel link, a wheel link fixed pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.8 Control Link Floating Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link floating pivot, or two, three, four, five or more control link floating pivots. In certain embodiments, a control link floating pivot of a suspension system of the invention is located below a control link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a control link floating pivot of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link, a first shock pivot, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.9 First Shock Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a first shock pivot, or two, three, four, five or more first shock pivots. In certain embodiments, a first shock pivot of a suspension system of the invention is located below a control link floating pivot, a control link fixed pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a first shock pivot of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.10 Second Shock Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a second shock pivot, or two, three, four, five or more second shock pivots. In certain embodiments, a second shock pivot of a suspension system of the invention is located below a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a shock absorber, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a second shock pivot of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a shock absorber, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.11 Wheel Rotation Axis of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel rotation axis, or two or more wheel rotation axes. In certain embodiments, a wheel rotation axis of a suspension system of the invention is concentric with a wheel link floating pivot of the vehicle, preferably the wheel rotation axis of a rear wheel of the vehicle. In certain other embodiments, a wheel rotation axis is nearly concentric with a wheel link floating pivot of the vehicle. A wheel rotation axis is nearly concentric with a wheel link floating pivot if the axis the pivot turns around is within 2 cm of the wheel rotation axis, or within 5 cm, or within 10 cm, or within 15 cm, or when the wheel axis and pivot axis are from 2 to 20 cm away from each other, or from 5 to 15 cm, or from 5 to 10 cm.

In certain embodiments, a wheel rotation axis of a suspension system of the invention is located below a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even

ground when even ground is perpendicular to gravity. In certain embodiments, a wheel rotation axis of a suspension system of the invention is located above a wheel link, a wheel link fixed pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.12 Shock Absorbers of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a shock absorber, or two, three, four, five or more shock absorbers. A shock absorber, in certain embodiments, may be a damper, a spring, a compression gas spring, a leaf spring, a coil spring, or a fluid. In certain embodiments, a shock absorber of a suspension system of the invention is located below a control link floating pivot, a control link fixed pivot, a first shock pivot, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a shock absorber of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a first shock pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.13 Control Link Force Lines of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link force line, or two, three, four, five or more control link force lines. In certain embodiments, a control link force line projects through a control link fixed pivot and a control link floating pivot of a suspension system of the invention. A control link force line, in certain embodiments, is parallel or substantially parallel to the ground, or at an angle of minus 60 to plus 60 degrees, or minus 45 to plus 45 degrees, or minus 30 to plus 30 degrees, or minus 15 to plus 15 degrees, or minus 10 to plus 10 degrees, or minus 5 to plus 5 degrees relative to the ground, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line descends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line ascends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line descends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 60 degrees, or 10 to 90 degrees, or 30 to 80 degrees, or 50 to 80 degrees, or 60 to 80 degrees, when the vehicle is on even ground when even ground is perpendicular to gravity and the suspension is fully compressed. In certain other embodiments, a control link force line projects from the rear to the front of the vehicle at an angle of −90 to 90 degrees, −50 to 50 degrees, 0 to 90 degrees, or 0 to 60 degrees, or 1 to 50 degrees, or 2 to 20 degrees, or 2 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line projects from the rearward in relation to the driven wheel at an angle of −90 to 90 degrees, −50 to 50 degrees, 0 to 90 degrees, or 0 to 60 degrees, or 1 to 50 degrees, or 2 to 20 degrees, or 2 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.14 Wheel Link Force Lines of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link force line, or two, three, four, five or more wheel link force lines. In certain embodiments, a wheel link force line projects through a wheel link fixed pivot and a wheel link floating pivot of a suspension system of the invention. A wheel link force line, in certain embodiments, is parallel or substantially parallel to the ground, or at an angle of minus 60 to plus 60 degrees, or minus 45 to plus 45 degrees, or minus 30 to plus 30 degrees, or minus 15 to plus 15 degrees, or minus 10 to plus 10 degrees, or minus 5 to plus 5 degrees relative to the ground, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a wheel link force line descends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 30 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a wheel link force line ascends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 30 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a wheel link force line descends from the rear to the front of the vehicle at an angle of 10 to 90 degrees, or 30 to 80 degrees, or 50 to 80 degrees, or 60 to 80 degrees, when the vehicle is on even ground when even ground is perpendicular to gravity and the suspension is fully compressed. In certain other embodiments, a wheel link force line projects from the rear to the front of the vehicle at an angle of −90 to 90 degrees, −50 to 50 degrees, −30 to 30 degrees, −15 to 45 degrees, −20 to 20 degrees, −10 to 10 degrees when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.15 Instant Force Centers of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises an instant force center, or two, three, four, five or more instant force centers. An instant force is a point where a control link force line of a suspension system of the invention intersects with a wheel link force line of that suspension system. In certain other embodiments, a control link force line and a wheel link force line of a suspension system of the invention intersect when the suspension is uncompressed, when the suspension is fully compressed, and/or at any point of partial compression of the suspension system. In certain other embodiments, an instant force center

of a suspension system of the invention is in different locations when the suspension is uncompressed and when the suspension is fully compressed. In certain embodiments, an instant force center of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, an instant force center of a suspension system of the invention is located below a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, an instant force center of a suspension system of the invention is located behind a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, an instant force center of a suspension system of the invention is located further to the front of the vehicle than a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

In certain embodiments of a suspension of the invention, an instant force center location is governed by the angle between and location of a wheel link and control link, and the closer to parallel a wheel link and control link are, the nearer to infinity is the instant force center perpendicular distance to the ground. In certain other embodiments, an instant force center of a suspension system of the invention has a first perpendicular distance from the ground, when the ground is level and perpendicular to gravity and when the suspension is uncompressed. In certain embodiments, an instant force center of a suspension system of the invention has a second perpendicular distance from the ground when the ground is level and perpendicular to gravity, when the suspension is compressed to a point further in the travel (in other words, partially to fully compressed), for example, when the suspension is 40 percent compressed, or 50 percent, or 60 percent, or fully compressed (in other words, 100 percent compressed). In certain other embodiments, the difference between the first perpendicular distance and second perpendicular distance can vary, for example, the difference may be from 0 to infinity, or 0 to 10,000 meters (m), or 0 to 5000 m, or 0 to 2500 m, or 0 to 1000 m, or 0 to 100 m, or 0 to 10 m, or 0 to 0.5 m, or 0 to 0.2 m, 0 to 0.1 m.

5.16 Further Embodiments of the Invention

A vehicle using a suspension of the invention may, in certain embodiments, comprise a measurable suspension parameter, a link length or link lengths measured from the center of one link pivot to another, vehicle metrics, a frame, a moving suspension component, a pivot, a rotary motion device, a motion control device, and/or a power-train component.

A measurable suspension parameter and vehicle metrics, in certain embodiments, may comprise a wheelbase, track width, camber, caster, anti squat, pro squat, zero squat, squat, rake, trail, offset, fork offset, spindle offset, chainstay length, swingarm length, distance between driven wheel rotation axis and power unit output spindle axis, chain length, belt length, bottom bracket, bottom bracket offset, drive spindle, drive spindle offset, drive spindle height, wheel diameter, driven wheel diameter, driven wheel spindle height, chainstay slope, chainstay rise, center of mass, center of mass height, center of mass offset, center of mass offset from drive spindle, length, magnitude, top tube length, downtube length, front center distance, seat tube length, seatstay length, headset stack height, head tube angle, fork angle, impact angle, fork rake, crown rake, handlebar height, bar height, bar sweep, handlebar sweep, handlebar rise, bar rise, crank length, crank arm length, pitch diameter, gear pitch diameter, sprocket pitch diameter, cog pitch diameter, front gear pitch diameter, front sprocket pitch diameter, front cog pitch diameter, rear gear pitch diameter, rear sprocket pitch diameter, rear cog pitch diameter, first intermediate gear pitch diameter, second intermediate gear pitch diameter, first intermediate sprocket pitch diameter, second intermediate sprocket pitch diameter, first intermediate cog pitch diameter, second intermediate cog pitch diameter, instant center, instant force center, center of curvature, axle path, axle path center of curvature, moving center of curvature, forward moving center of curvature, forward moving instant center, rearward moving instant center, instant center movement direction change, center of curvature path, instant center path, instant center path focus, moving instant center path focus, virtual force center, virtual instant force center, virtual force center path, driving force, chain force, anti rotation force, sprocket force, bevel gear force, rotational force, driving force vector, chain pull, chain pull force, chain pull force vector, idler gear height, idler gear pitch diameter, idler cog pitch diameter, idler sprocket pitch diameter, jackshaft gear pitch diameter, jackshaft cog pitch diameter, jackshaft sprocket pitch diameter, leverage rate, leverage ratio, damper leverage rate, damper leverage ratio, spring leverage rate, spring leverage ratio, wheel motion ratio, wheel rate, spring rate, damping rate, leverage rate progression curve, leverage rate progression, progressive rate, regressive rate, straight rate, varying rate, suspension compression, full suspension compression, suspension extension, full suspension extension, droop travel, full droop travel, suspension ride height, static ride height, neighed ride height, laden ride height, weighted ride height, beginning of travel, middle of travel, end of travel, 0 percent travel to 20 percent travel, 20 percent travel to 80 percent travel, 80 percent travel to 100 percent travel, 0 percent travel to 25 percent travel, 25 percent travel to 75 percent travel, 75 percent travel to 100 percent travel, 0 percent travel to 30 percent travel, 30 percent travel to 65 percent travel, 65 percent travel to 100 percent travel, 0 percent travel to 35 percent travel, 35 percent travel to 60 percent travel, 60 percent travel to 100 percent travel, powertrain component rotation axis, driven wheel rotation axis, non driven wheel rotation axis, sprocket rotation axis, axis, axis location, rear wheel rotation axis, front wheel rotation axis, contact patch, tire contact patch, tire to ground contact patch, driven wheel tire to ground contact patch, non driven wheel tire to ground contact patch, front wheel tire to ground contact patch, rear wheel tire to ground contact patch, chain force vector, driving force vector, squat

force vector, first carrier manipulation link force vector, second carrier manipulation link force vector, squat definition point, squat layout line, lower squat measurement definition line, measured squat distance, driven wheel axle path, driven wheel suspension travel distance, stable squat magnitude curve, defines a squat magnitude curve upper bound, a squat magnitude curve lower bound, instant force center, driven wheel rotation axis, chain force vector and driving force vector intersection point, driving cog rotation axis, center of the forward wheel tire to ground contact patch, center of the driven wheel tire to ground contact patch, vehicle center of sprung mass, 200 percent squat point, 200 percent measurement value, direction of gravity, squat magnitude definition point, squat magnitude, center of mass intersection vector, squat magnitude definition vector, percent squat magnitude variation, first squat magnitude curve slope, first squat magnitude curve slope, second squat magnitude curve slope, third squat magnitude curve slope, instant force center path, instant force center path focus, pitch diameter, driven idler cog rotation axis, instant force center position uncompressed, instant force center position compressed, instant force center movement, and/or an instant force center movement.

A frame, in certain embodiments, may be comprised of a solid beam, a solid bar, a metal bar, a plastic bar, a composite bar, a tube, a metal tube, an aluminum tube, a titanium tube, a steel tube, a composite tube, a carbon tube, a boron tube, an alloy tube, a magnesium tube, a stiff tube, a flexible tube, a thin walled tube, a thick walled tube, a butted tube, a single butted tube, a double butted tube, a triple butted tube, a quadruple butted tube, a straight gage tube, a round tube, a square tube, a rectangular tube, a rounded corner tube, a shaped tube, an aero tube, a streamline tube, a plus shaped tube, a bat shaped tube, a tube that transitions from a round tube to a rectangular tube, a tube that transitions from a round tube to a square tube, a tube that transitions from a round tube to a rounded corner tube, a tube that transitions from a round tube to a shaped tube, welding, MIG welding, TIG welding, laser welding, friction welding, a welded tube, a TIG welded tube, a MIG welded tube, a laser welded tube, a friction welded tube, a monocoque section, a monocoque frame, metal monocoque, TIG welded monocoque, MIG welded monocoque, laser welded monocoque, friction welded monocoque, carbon monocoque, Kevlar monocoque, fiberglass monocoque, composite monocoque, fiberglass, carbon fiber, foam, honeycomb, stress skin, braces, extrusion, extrusions, metal inserts, rivets, screws, castings, forgings, CNC machined parts, machined parts, stamped metal parts, progressive stamped metal parts, tubes or monocoque parts welded to cast parts, tubes or monocoque parts welded to forged parts, tubes or monocoque parts welded to machined parts, tubes or monocoque parts welded to CNC machined parts, glue, adhesive, acrylic adhesive, methacrylate adhesive, bonded panels, bonded tubes, bonded monocoque, bonded forgings, bonded castings, tubes bonded to CNC machined parts, tubes bonded to machined parts, tubes bonded to castings, tubes bonded to forgings, gussets, supports, support tubes, tabs, bolts, tubes welded to tabs, monocoque welded to tabs, tubes bolted to tabs, injection molded parts, seatstays, chainstays, a seatstay, a chainstay, a seat tube, seat tower, seatpost, seat, top tube, upper tube, downtube, lower tube, top tubes, down tubes, seat tube brace, and/or a seat tube support.

A moving suspension component of a suspension system of the invention, according to certain embodiments, may be comprised of a link, a wheel carrier link, a wheel carrier, a carrier manipulation link, an upper carrier manipulation link, lower carrier manipulation link, first carrier manipulation link, second carrier manipulation link, swingarm, swingarms, swinging arm, swinging arms, swing link, swing links, first link, second link, upper link, lower link, top link, bottom link, forward link, rearward link, front link, back link, primary link, secondary link, flexure, flexures, first flexure, second flexure, upper flexure, lower flexure, top flexure, bottom flexure, forward flexure, rearward flexure, front flexure, back flexure, primary flexure, secondary flexure, carrier manipulation flexures, sliders, curved sliders, straight sliders, complex curved sliders, carriers, tracks, curved tracks, straight tracks, complex curved tracks, bearings, cams, gears, seals, pivots, shock link, linkages, shock driving links, A-Arms, H-Arms, support arms, upper support, lower support, double arms, single arms, single pivot, multi pivot, SLA, Short Long Arm, hub carrier, wheel carrier, spindle, spindle carrier, wheel support, spindle support, trailing arm, semi-trailing arm, swingarm, double swingarm, parallel links, semi-parallel links, perpendicular links, strut, MacPherson strut, suspension strut, linear bearing, linear bushing, stanchion, fork, fork lower, 4-bar linkage, 5-bar linkage, 6-bar linkage, 7 bar linkage, 8 bar linkage, linkage, multi link, trackbar, panhard bar, watts link, watt link, ball joints, heim joint, radial joint, rotary joint, internal damper, external damper, enclosed damper, enclosed spring, caster block, camber block, caster wedge, driven wheel, vehicle chassis, first link fixed pivot , second link fixed pivot, first link floating pivot, second link floating pivot, driving cog, driven cog, forward wheel, driven idler cog, spring damper unit, first carrier manipulation track, second carrier manipulation track, first carrier manipulation slider, second carrier manipulation slider, first carrier manipulation slider pivot, second carrier manipulation slider pivot, stiffening link, and/or a stiffening linkage.

A pivot and a rotary motion devices of a suspension of the invention, according to certain embodiments, may be comprised of a pivot, a main pivot, a chainstay pivot, a seatstay pivot, an upper main pivot, a lower frame pivot, an upper frame pivot, a bottom frame pivot, a top frame pivot, a forward frame pivot, a rearward frame pivot, a front frame pivot, a rear frame pivot, a primary frame pivot, a secondary frame pivot, a tertiary frame pivot, a first frame pivot, a second frame pivot, a third frame pivot, a fourth frame pivot, combinations of pivots, bearing pivots, bushing pivots, bearings, bushings, seals, grease ports, greased pivots, oiled pivots, needle bearing pivots, journal bearing pivots, DU bearing pivots, plastic bushing pivots, plastic bearing pivots, a flexure, flexures, composite flexures, titanium flexures, aluminum flexures, steel flexures, aluminum pivot shafts, stainless steel pivot shafts, steel pivot shafts, titanium pivot shafts, plastic pivot shafts, composite pivot shafts, hardened bearing races, hardened pivot shafts, anodized pivot shafts, plated pivot shafts, coated pivot shafts, bearing caps, bearings seals, o-rings, o-ring seals, x-rings, and/or a x-ring seal.

A motion control device of a suspension of the invention, according to certain embodiments, may be comprised of a shock, a shock absorber, a spring damper unit, a damper, a spring, a coil spring, a leaf spring, a compression spring, an extension spring, an air spring, a nitrogen spring, a gas spring, a torsion spring, a constant force spring, a flat spring, a wire spring, a carbon spring, a negative spring, a positive spring, a progressive spring, multiple springs, stacked springs, springs in series, springs in parallel, springs separate from a damper unit, a damper unit, hydraulics, hydraulic pistons, hydraulic valves, air valves, air cans, gears, cams, a cam, a gear, non-circular gears, linear damper, rotary damper, vane damper, friction damper, poppet valve, compensation spring, negative spring, elastomer, rubber bumper, bumper, progressive bumper, hydraulic bottoming bumper, pressure compensa-

tion, heat compensation, oil, water, damping fluid, cooling fluid, shims, pressure, shaft, through shaft, eyelet, adjusters, compensator, hose, reservoir, remote reservoir, low speed adjuster, high speed adjuster, mid range adjuster, bypass circuit, foot valve, large bump adjuster, small bump adjuster, high velocity adjuster, low velocity adjuster, hydraulic ram, hydraulic piston, active suspension, and/or a microprocessor.

A powertrain component of a suspension of the invention, according to certain embodiments, may be comprised of an energy storage device, a battery, fuel, a fuel tank, a flywheel, a liquid fuel, solid fuel, rocket fuel, a reactor, steam, a nuclear reactor, a fusion reactor, pressure, air pressure, hydraulic pressure, gas pressure, expanding gas, a motor, an electric motor, a hydraulic motor, a turbine motor, a steam turbine, a gas turbine motor, an engine, a gasoline engine, a diesel engine, diesel, gasoline, alcohol, sterling engine, a two stroke engine, a four stroke engine, miller cycle engine, ramjet engine, turbine engine, rocket engine, human power, horse power, animal power, potential energy, spring, compression spring, extension spring, constant force spring, progressive spring, power transfer components, wire, rope, string, chain, belt, shaft, gear, cog, cam, sprocket, pulley, lever, clutch, one way clutch, one way bearing, bearing, ball bearing, journal bearing, bushing, drive sprocket, driven sprocket, drive cog, driven cog, drive gear, driven gear, intermediate cog, intermediate sprocket, intermediate gear, idler cog, idler sprocket, idler gear, bottom bracket, bottom bracket spindle, crank arm, foot pedal, pedal, hand crank, cassette, sprocket cluster, derailleur, front derailleur, rear derailleur, chainguide, single ring chainguide, dual ring chainguide, multi ring chainguide, shifter, shift lever, shifter cable, shifter hose, hydraulic shifting, air shifting, pneumatic shifting, gearbox, transmission, continuously variable transmission, infinitely variable transmission, direct drive, tire, wheel, track, track segment, idler wheel, jet, driving cog, driven cog, forward wheel, driven idler cog.

Certain embodiments of the current invention may comprise a braking system which could further comprise disc brakes, calipers, disc caliper, hydraulic brakes, mechanical brakes, brake levers, brake hose, brake cable, brake pads, caliper brakes, rim brakes, V-brakes, cantilever brakes, friction brakes, wheel brake, mounting bolts, international brake standard mounting.

A suspension of the invention will comprise a linkage system which further comprise pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by tactical placement of an instant force center, and so that acceleration forces can be controlled by the placement of a fixed pivot or pivots of a swinging wheel link.

The present invention is not to be limited in scope by the specific embodiments described herein, which are intended as single illustrations of individual aspects of the invention, and functionally equivalent methods and components are within the scope of the invention. Indeed, various modifications of the invention, in addition to those shown and described herein, will become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within the scope of the appended claims. Throughout this application the singular includes the plural and the plural includes the singular, unless indicated otherwise. All cited publications, patents, and patent applications are herein incorporated by reference in their entirety.

What is claimed is:

1. A suspension system for a vehicle comprising a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link and a shock absorber, wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link; wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid; and wherein force that compresses said shock absorber is transmitted through said brake link; and wherein said brake link passes on two sides of a frame member.

2. The suspension system of claim **1**, said suspension system further comprising, a control link floating pivot and a wheel link fixed pivot.

3. The suspension system of claim **1**, said suspension system further comprising a wheel link fixed pivot and a control link floating pivot.

4. The suspension system of claim **3**, said suspension system further comprising an instant center that is further to the front of the vehicle than the shock absorber when the suspension is uncompressed.

5. The suspension system of claim **3**, said suspension system further comprising an instant center that is below the shock absorber when the suspension is uncompressed.

6. The suspension system of claim **3**, said suspension system further comprising an instant center that is closer to the ground when the suspension is fully compressed compared to the when the suspension is uncompressed.

7. The suspension system of claim **3**, said suspension system further comprising an instant center that has a first perpendicular distance to the ground when the suspension is uncompressed and a second perpendicular distance to the ground when the suspension is compressed.

8. The suspension of claim **7**, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is 50 percent compressed.

9. The suspension of claim **7**, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is fully compressed.

10. The suspension of claim **7**, where the difference between first perpendicular distance and second perpendicular distance is from 0 to 10000 m.

11. The suspension system of claim **3**, said suspension system further comprising a control link force line that descends from the rear to the front of the vehicle at an angle of 0 to 50 degrees when the suspension is uncompressed and the vehicle is on even ground.

12. The suspension system of claim **3**, said suspension system further comprising a control link force line that is at an angle of minus 30 to plus 30 degrees relative to the ground when the suspension is uncompressed and the vehicle is on even ground.

13. The suspension system of claim **3**, said suspension system further comprising a wheel link force line that ascends from the rear to the front of the vehicle at an angle of 0 to 50 degrees when the suspension is uncompressed and the vehicle is on even ground.

14. The suspension system of claim **3**, said suspension system further comprising a wheel link force line that is at an angle of minus 10 to plus 10 degrees relative to the ground when the suspension is uncompressed and the vehicle is on even ground.

15. The suspension system of claim **3**, said suspension system further comprising a wheel link force line that projects from the rear to the front of the vehicle at an angle of −15 to 45 degrees when the suspension is uncompressed and the vehicle is on even ground.

16. The suspension system of claim **3**, said suspension system further comprising a control link force line that descends from the rear to the front of the vehicle at an angle

of 0 to 60 degrees when the vehicle is on even ground and the suspension is fully compressed.

17. The suspension system of claim 3, said suspension system further comprising a wheel link force line that descends from the rear to the front of the vehicle at an angle of 0 to 30 degrees when the vehicle is on even ground and the suspension is fully compressed.

18. The suspension system of claim 3, said suspension system further comprising a wheel link force line that projects from the rear to the front of the vehicle at an angle of −30 to 30 degrees when the vehicle is on even ground and the suspension is fully compressed.

19. The suspension system of claim 1, wherein said wheel link and said brake link are arranged at an angle of 10 to 60 degrees when the suspension is uncompressed and the vehicle is on even ground.

20. The suspension system of claim 1, wherein said wheel link is 5 to 20 percent shorter than said brake link.

21. The suspension system of claim 1, said suspension system further comprising a control link that is 2 to 25 cm in length.

22. A suspension system for a vehicle comprising a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link, a control link and a shock absorber, wherein said wheel link floating pivot is concentric with said wheel rotation axis and where said wheel link and said control link are arranged so that an instant center of the suspension system is located below the control link when the suspension is uncompressed and the vehicle is on even ground; wherein said shock absorber is mounted to a link selected from the group consisting of a brake link, a control link, and a wheel link; wherein force that compresses said shock absorber is transmitted though said brake link; wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid; and wherein said suspension system further comprises a wheel link fixed pivot, a control link floating pivot and a control link fixed pivot.

23. The suspension system of claim 22, said suspension system further comprising a control link floating pivot and a wheel link fixed pivot.

24. The suspension system of claim 22, said suspension system further comprising an instant center that is further to the front of the vehicle than the shock absorber when the suspension is uncompressed and the vehicle is on even ground.

25. The suspension system of claim 22, said suspension system further comprising an instant center that is below the shock absorber when the suspension is uncompressed and the vehicle is on even ground.

26. The suspension system of claim 22, said suspension system further comprising an instant center that is closer to the ground when the suspension is fully compressed compared to the when the suspension is uncompressed and the vehicle is on even ground.

27. The suspension system of claim 22, said suspension system further comprising an instant center that has a first perpendicular distance to the ground when the suspension is uncompressed and a second perpendicular distance to the ground when the suspension is compressed.

28. The suspension of claim 27, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is 50 percent compressed.

29. The suspension of claim 27, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is fully compressed.

30. The suspension of claim 27, where the difference between first perpendicular distance and second perpendicular distance is from 0 to 10000 m.

31. The suspension system of claim 22, said suspension system further comprising a control link force line that descends from the rear to the front of the vehicle at an angle of 0 to 50 degrees when the suspension is uncompressed and the vehicle is on even ground.

32. The suspension system of claim 22, said suspension system further comprising a control link force line that is at an angle of minus 30 to plus 30 degrees relative to the ground when the suspension is uncompressed and the vehicle is on even ground.

33. The suspension system of claim 22, said suspension system further comprising a wheel link force line that ascends from the rear to the front of the vehicle at an angle of 0 to 50 degrees when the suspension is uncompressed and the vehicle is on even ground.

34. The suspension system of claim 22, said suspension system further comprising a wheel link force line that is at an angle of minus 10 to plus 10 degrees relative to the ground when the suspension is uncompressed and the vehicle is on even ground.

35. The suspension system of claim 22, said suspension system further comprising a wheel link force line that projects from the rear to the front of the vehicle at an angle of −15 to 45 degrees when the suspension is uncompressed and the vehicle is on even ground.

36. The suspension system of claim 22, said suspension system further comprising a control link force line that descends from the rear to the front of the vehicle at an angle of 0 to 60 degrees when the vehicle is on even ground and the suspension is fully compressed.

37. The suspension system of claim 22, said suspension system further comprising a wheel link force line that descends from the rear to the front of the vehicle at an angle of 0 to 30 degrees when the vehicle is on even ground and the suspension is fully compressed.

38. The suspension system of claim 22, said suspension system further comprising a wheel link force line that projects from the rear to the front of the vehicle at an angle of −30 to 30 degrees when the vehicle is on even ground and the suspension is fully compressed.

39. The suspension system of claim 22, wherein said wheel link and said brake link are arranged at an angle of 10 to 60 degrees when the suspension is uncompressed and the vehicle is on even ground.

40. The suspension system of claim 22, wherein said wheel link is 5 to 20 percent shorter than said brake link.

41. The suspension system of claim 22, wherein said brake link passes on two sides of a frame member.

42. The suspension system of claim 22, wherein said control link is 2 to 25 cm in length.

43. A suspension system for a vehicle comprising a wheel link floating pivot, a control link fixed pivot, a wheel rotation axis, a wheel link, a brake link, and a shock absorber, wherein said wheel link floating pivot is concentric with said wheel rotation axis, wherein said shock absorber is selected from the group consisting of a compression gas spring, a leaf spring, a coil spring, and a fluid; and wherein force is transmitted to said shock absorber through said brake link; wherein said brake link passes on two sides of a frame member.

44. The suspension system of claim 43, said suspension system further comprising a control link.

45. The suspension system of claim 43, said suspension system further comprising a brake link, a control link floating pivot and a wheel link fixed pivot.

46. The suspension system of claim **43**, said suspension system further comprising a wheel link fixed pivot and a control link floating pivot.

47. The suspension system of claim **46**, said suspension system further comprising an instant center that is further to the front of the vehicle than the shock absorber when the suspension is uncompressed and the vehicle is on even ground.

48. The suspension system of claim **46**, said suspension system further comprising an instant center that is below the shock absorber when the suspension is uncompressed and the vehicle is on even ground.

49. The suspension system of claim **46**, said suspension system further comprising an instant center that is closer to the ground when the suspension is fully compressed compared to the when the suspension is uncompressed and the vehicle is on even ground.

50. The suspension system of claim **46**, said suspension system further comprising an instant center that has a first perpendicular distance to the ground when the suspension is uncompressed and a second perpendicular distance to the ground when the suspension is compressed.

51. The suspension of claim **50**, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is 50 percent compressed.

52. The suspension of claim **50**, wherein the second perpendicular distance of the instant center to the ground is measured when the suspension is fully compressed.

53. The suspension of claim **46**, where the difference between first perpendicular distance and second perpendicular distance is from 0 to 10000 m.

54. The suspension system of claim **46**, said suspension system further comprising a control link force line that descends from the rear to the front of the vehicle at an angle of 1 to 50 degrees when the suspension is uncompressed and the vehicle is on even ground.

55. The suspension system of claim **46**, said suspension system further comprising a control link force line that is at an angle of minus 30 to plus 30 degrees relative to the ground when the suspension is uncompressed and the vehicle is on even ground.

56. The suspension system of claim **46**, said suspension system further comprising a wheel link force line that ascends from the rear to the front of the vehicle at an angle of 0 to 50 degrees when the suspension is uncompressed and the vehicle is on even ground.

57. The suspension system of claim **46**, said suspension system further comprising a wheel link force line that is at an angle of minus 10 to plus 10 degrees relative to the ground when the suspension is uncompressed and the vehicle is on even ground.

58. The suspension system of claim **46**, said suspension system further comprising a wheel link force line that projects from the rear to the front of the vehicle at an angle of −15 to 45 degrees when the suspension is uncompressed and the vehicle is on even ground.

59. The suspension system of claim **46**, said suspension system further comprising a control link force line that descends from the rear to the front of the vehicle at an angle of 0 to 60 degrees when the vehicle is on even ground and the suspension is fully compressed.

60. The suspension system of claim **46**, said suspension system further comprising a wheel link force line that descends from the rear to the front of the vehicle at an angle of 0 to 30 degrees when the vehicle is on even ground and the suspension is fully compressed.

61. The suspension system of claim **46**, said suspension system further comprising a wheel link force line that projects from the rear to the front of the vehicle at an angle of −30 to 30 degrees when the vehicle is on even ground and the suspension is fully compressed.

62. The suspension system of claim **43**, wherein said wheel link and said brake link are arranged at an angle of 10 to 60 degrees when the suspension is uncompressed and the vehicle is on even ground.

63. The suspension system of claim **43**, wherein said wheel link is 5 to 20 percent shorter than said brake link.

64. The suspension system of claim **43**, said suspension system further comprising a control link that is 2 to 25 cm in length.

* * * * *

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(12) **United States Patent**
Weagle

(10) **Patent No.: US 8,002,301 B2**
(45) **Date of Patent: Aug. 23, 2011**

(54) **VEHICLE SUSPENSION SYSTEMS FOR SEPERATED ACCELERATION RESPONSES**

(75) Inventor: **David Weagle**, Edgartown, MA (US)

(73) Assignee: **Split Pivot, Inc.**, Edgartown, MA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 564 days.

(21) Appl. No.: **11/895,269**

(22) Filed: **Aug. 23, 2007**

(65) **Prior Publication Data**

US 2008/0073868 A1 Mar. 27, 2008

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/510,522, filed on Aug. 25, 2006, now Pat. No. 7,717,212.

(51) **Int. Cl.**
B62K 3/02 (2006.01)

(52) **U.S. Cl.** **280/284**; 280/283; 280/285; 280/286; 280/288; 180/227

(58) **Field of Classification Search** 280/283–288; 180/277
See application file for complete search history.

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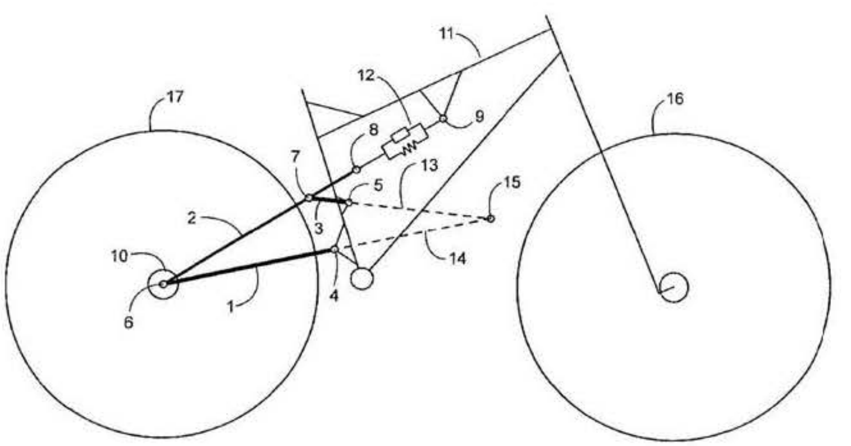
Primary Examiner — Anne Marie Boehler
Assistant Examiner — Maurice Williams
(74) *Attorney, Agent, or Firm* — Stahl Law Firm

(57) **ABSTRACT**

The invention relates to suspension systems comprising, in certain embodiments, a pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by placement of an instant force center, and so that acceleration forces can be controlled by a swinging wheel link.

97 Claims, 18 Drawing Sheets



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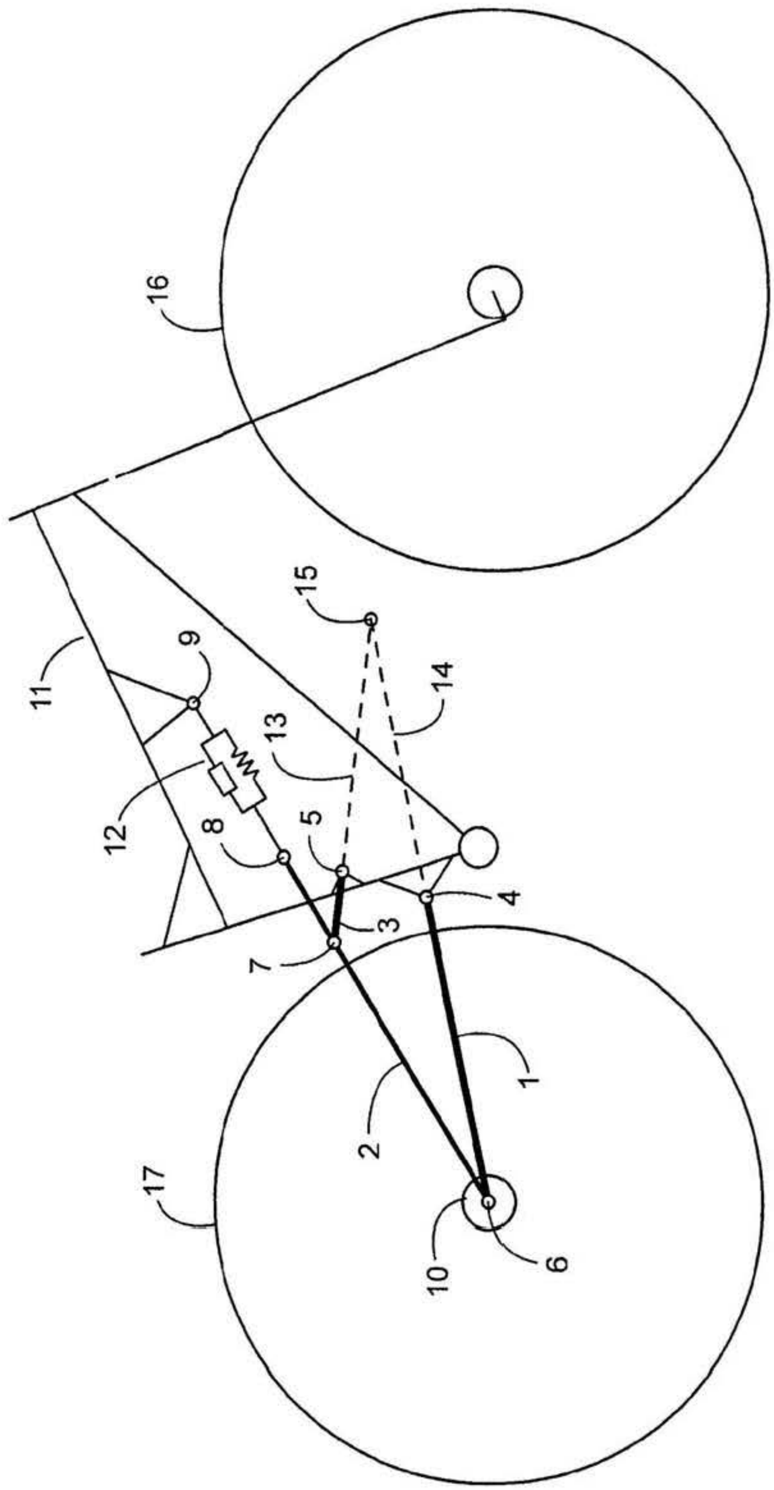

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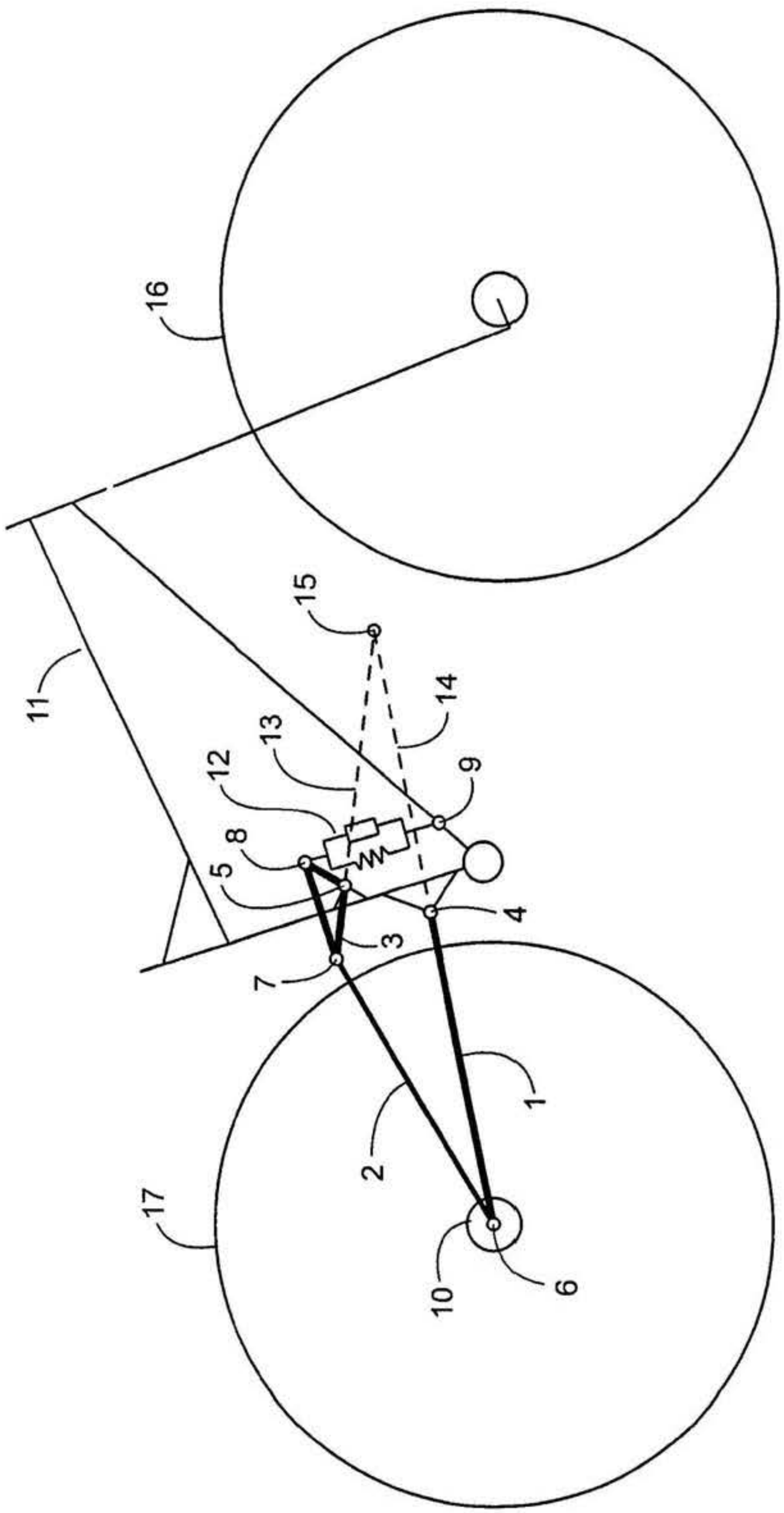

FIGURE 2

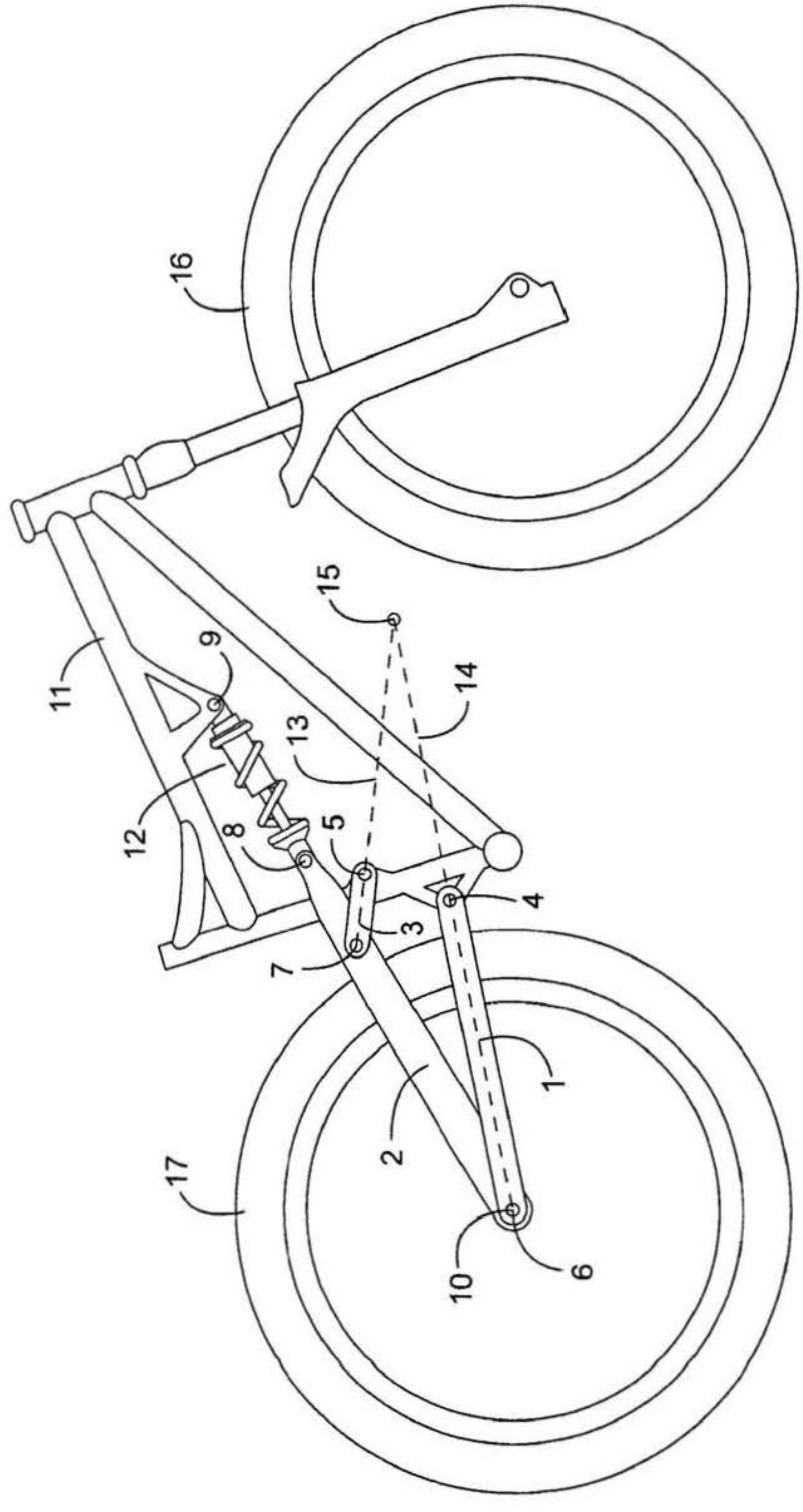

FIGURE 3

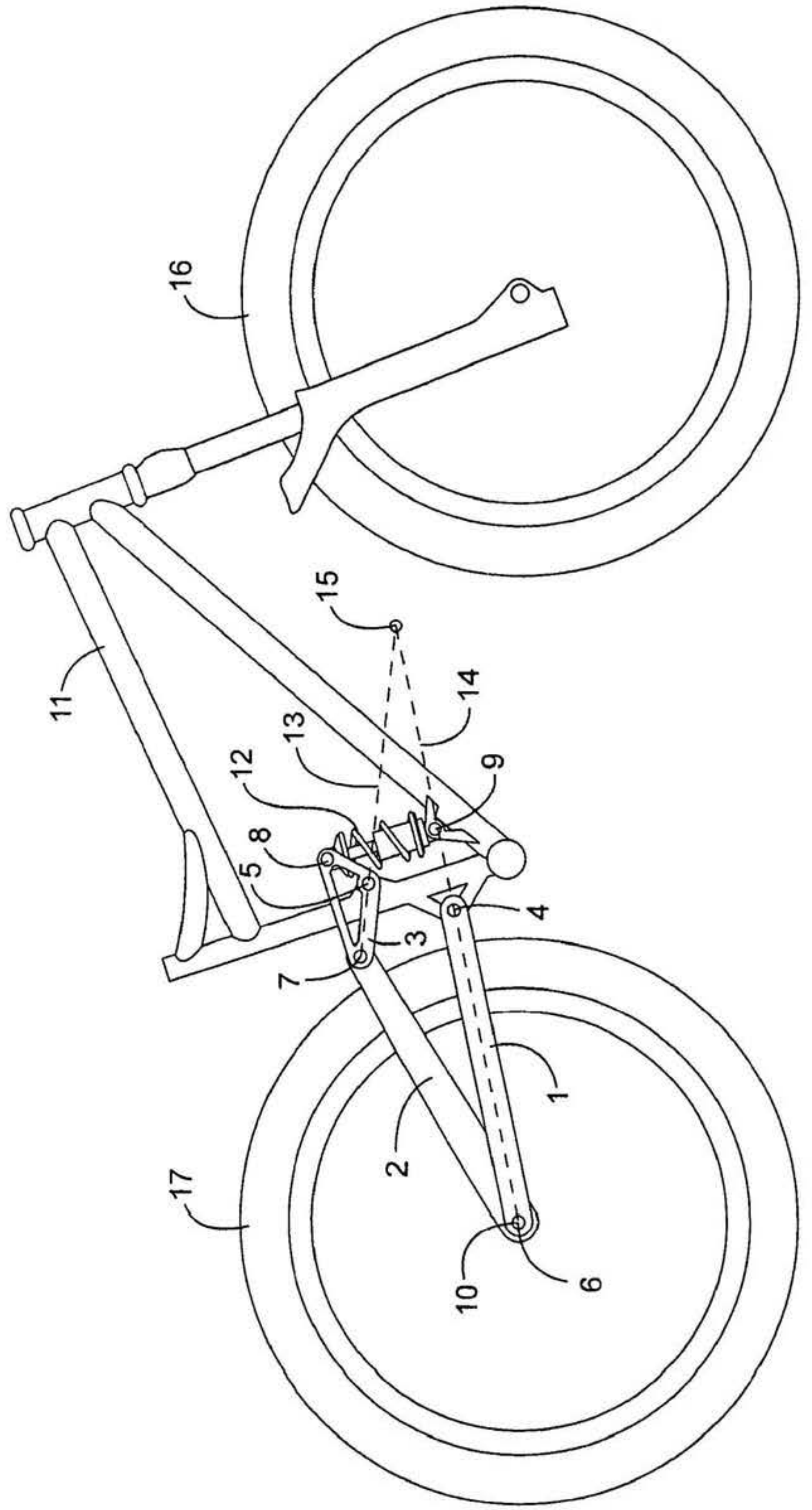

FIGURE 4

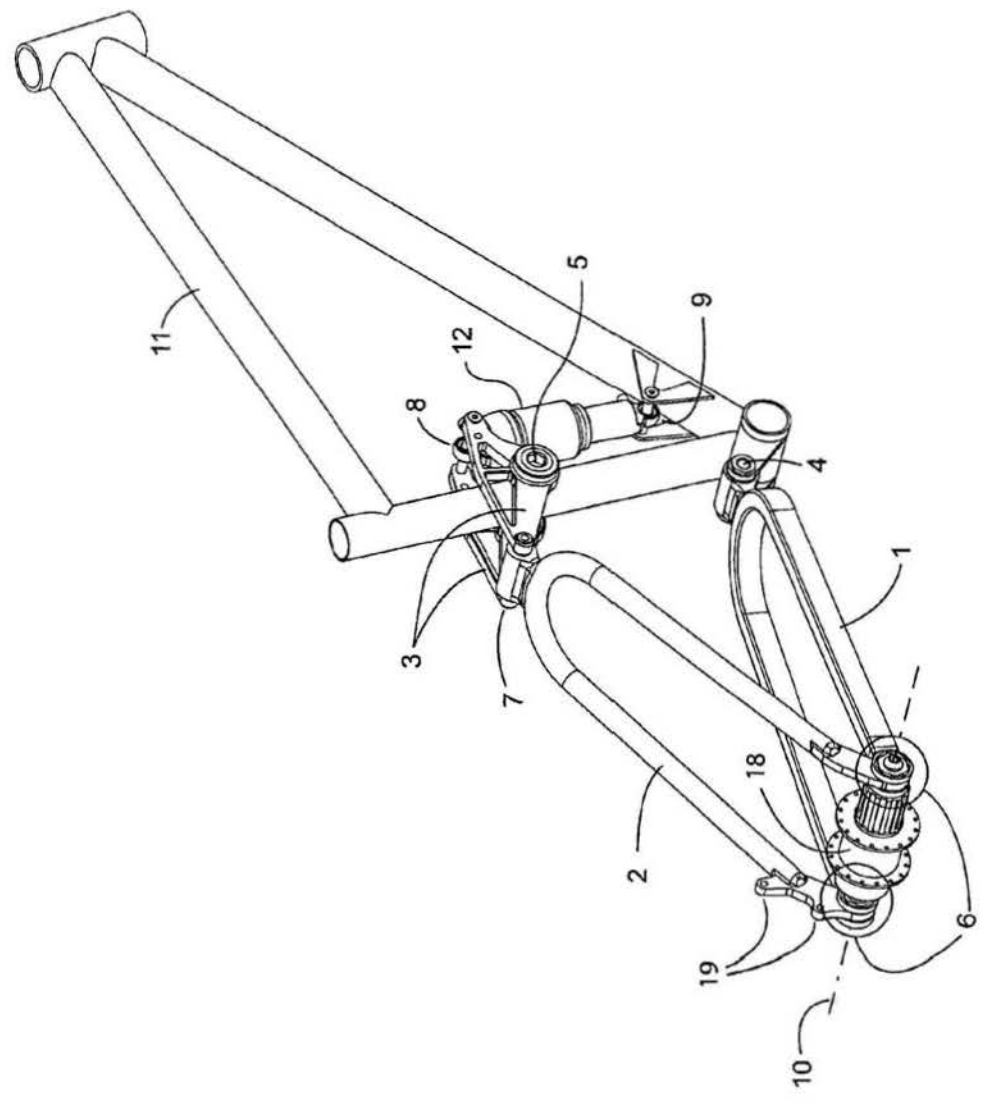

FIGURE 5

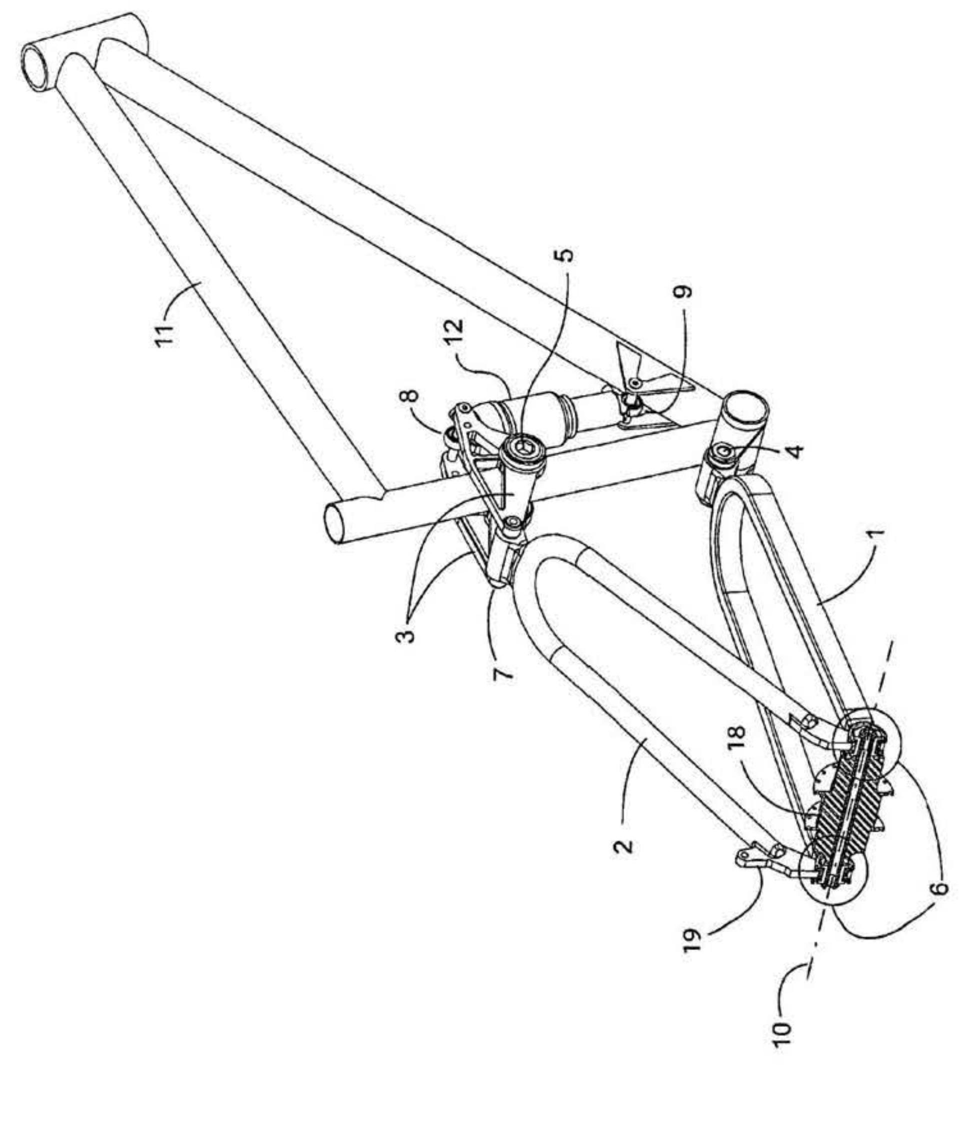

FIGURE 6

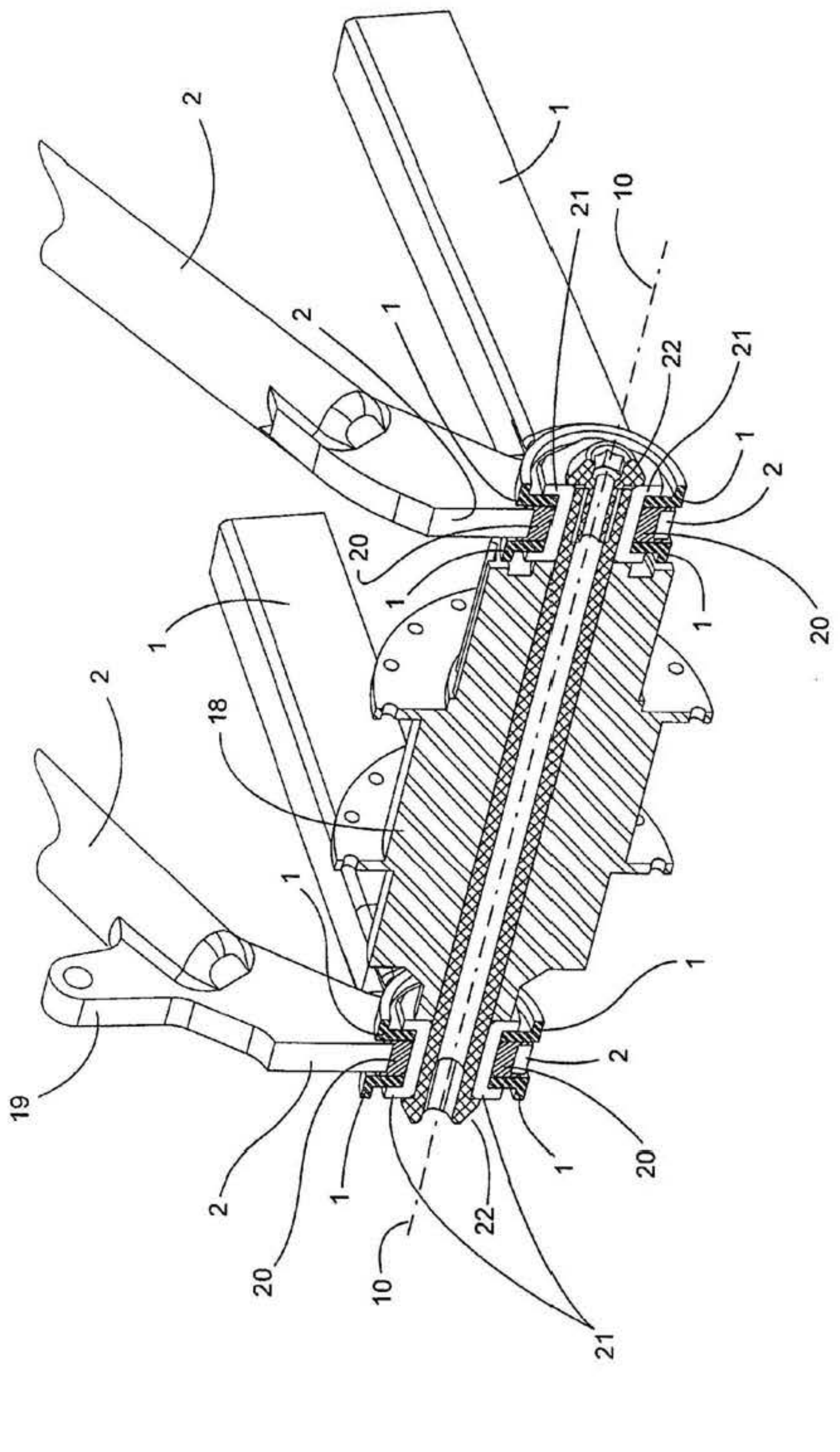

FIGURE 7

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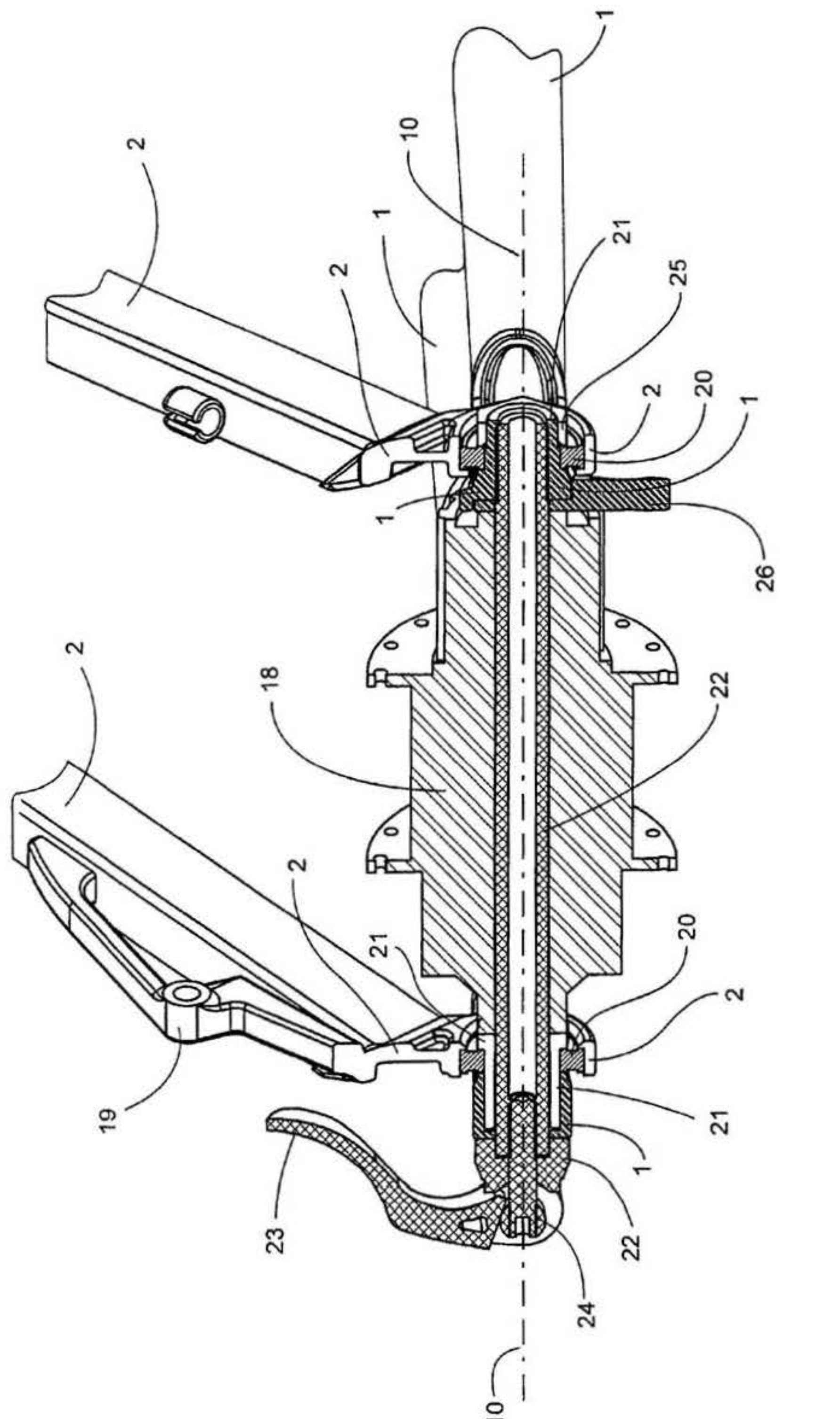

FIGURE 8

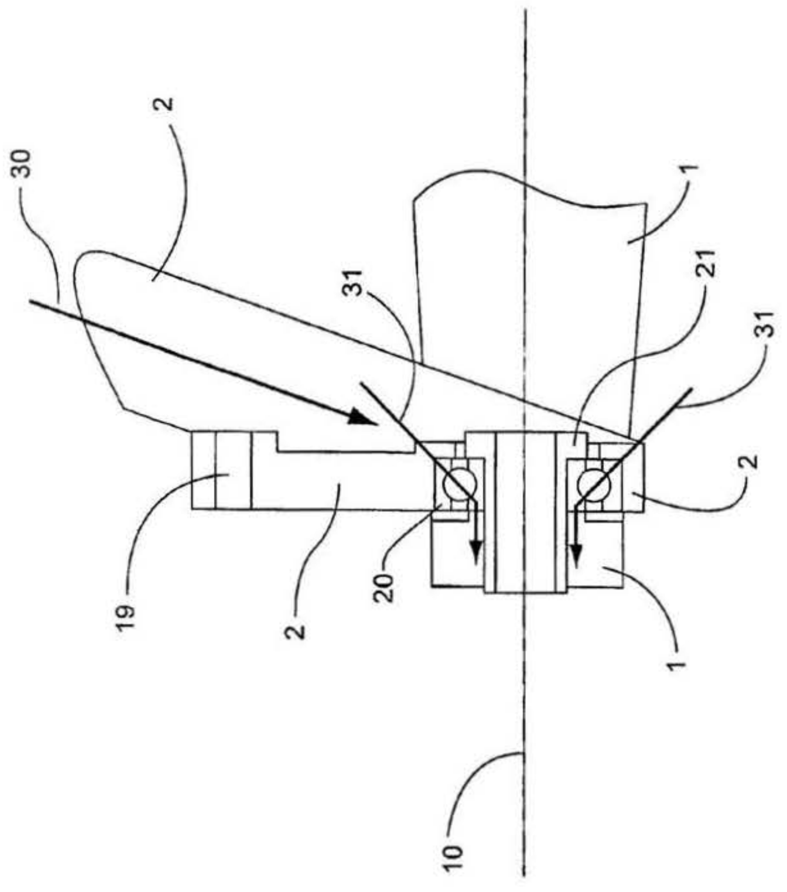

FIGURE 9

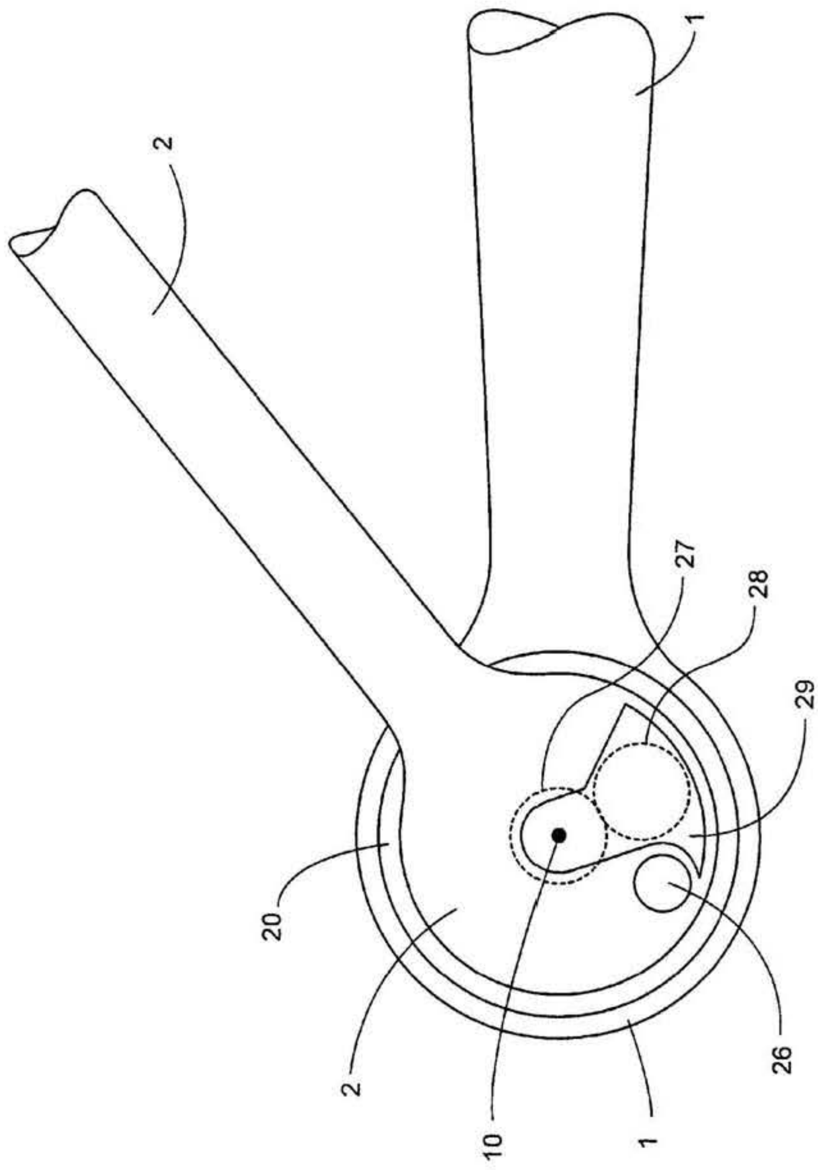

FIGURE 10

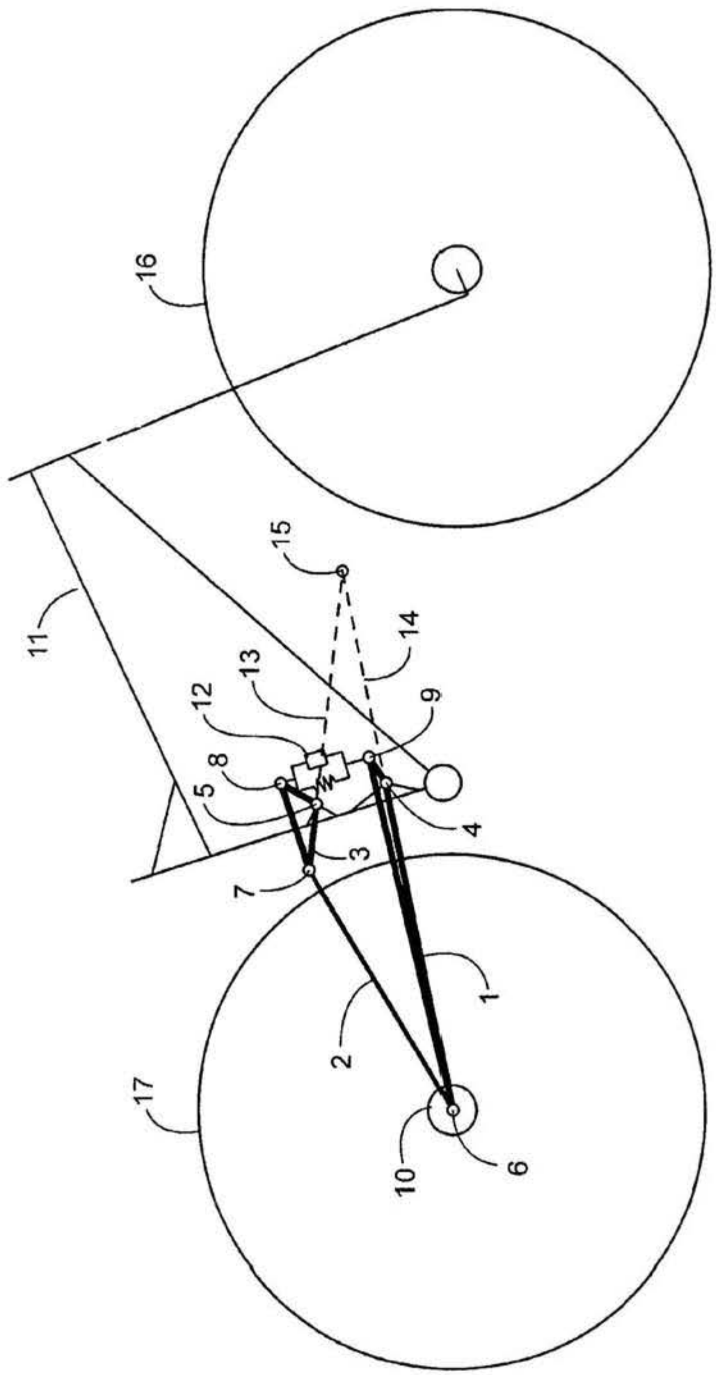

FIGURE 11

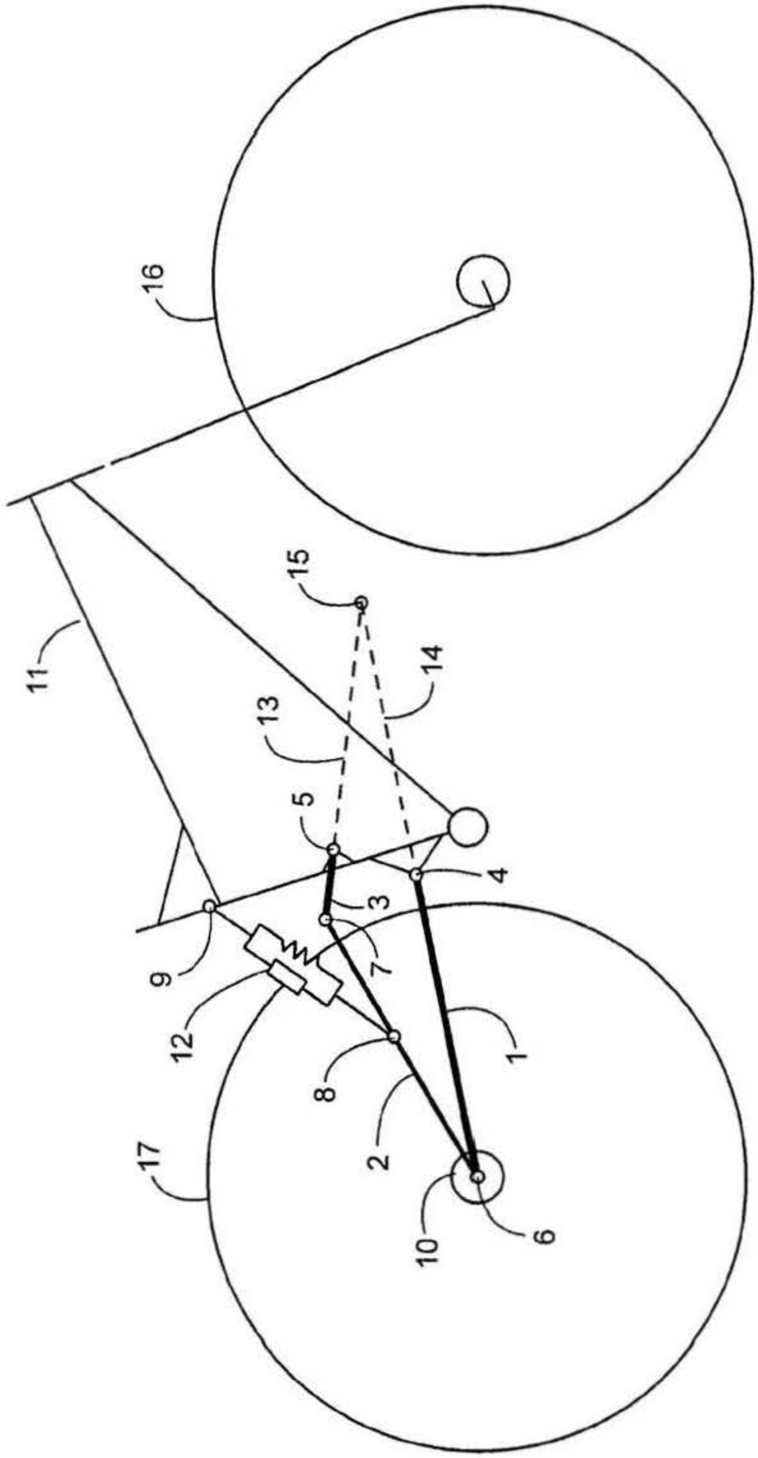

FIGURE 12

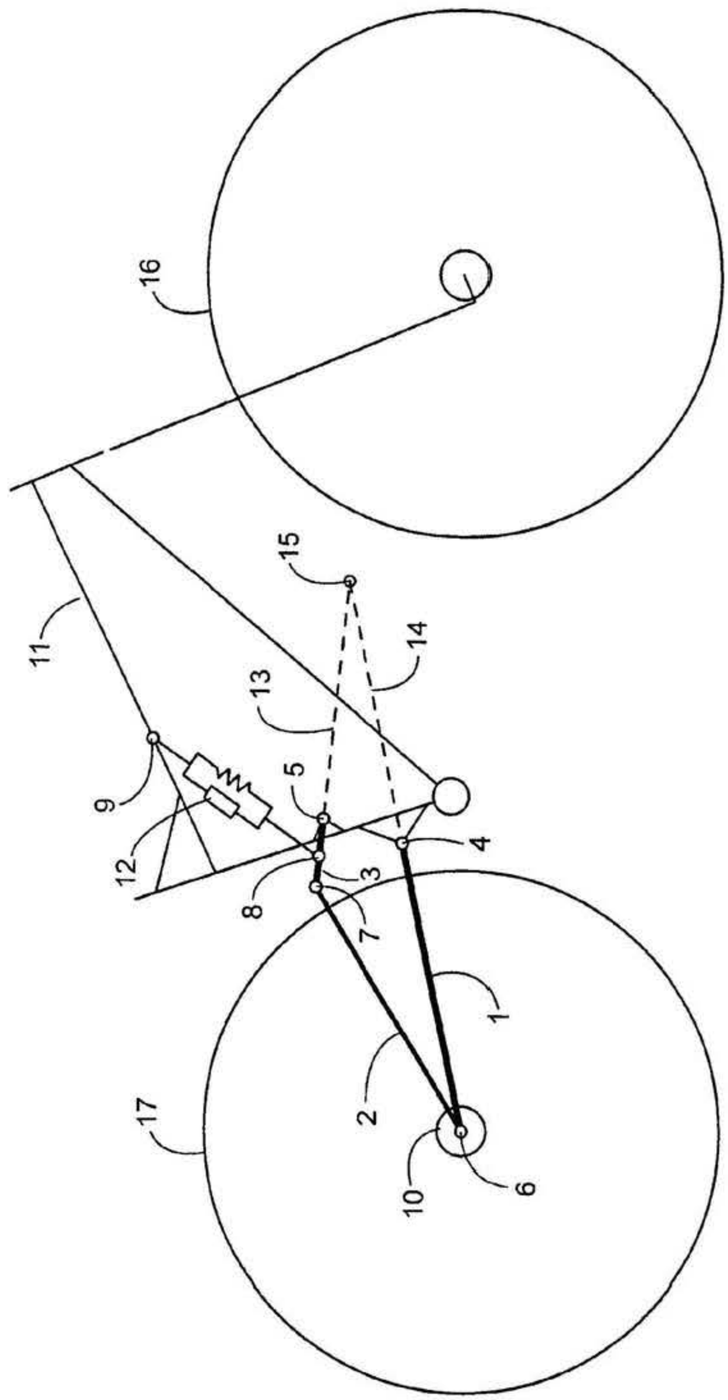

FIGURE 13

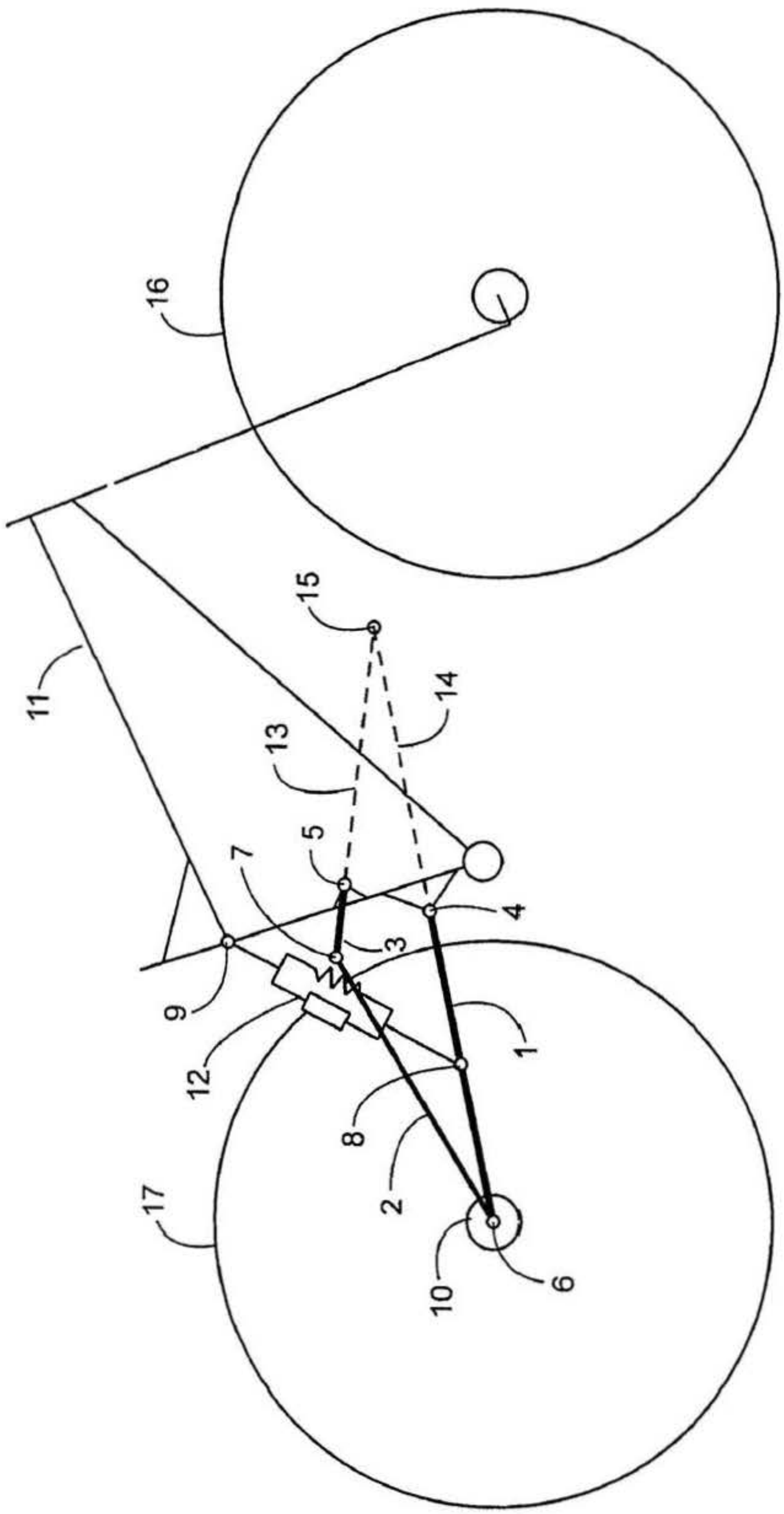

FIGURE 14

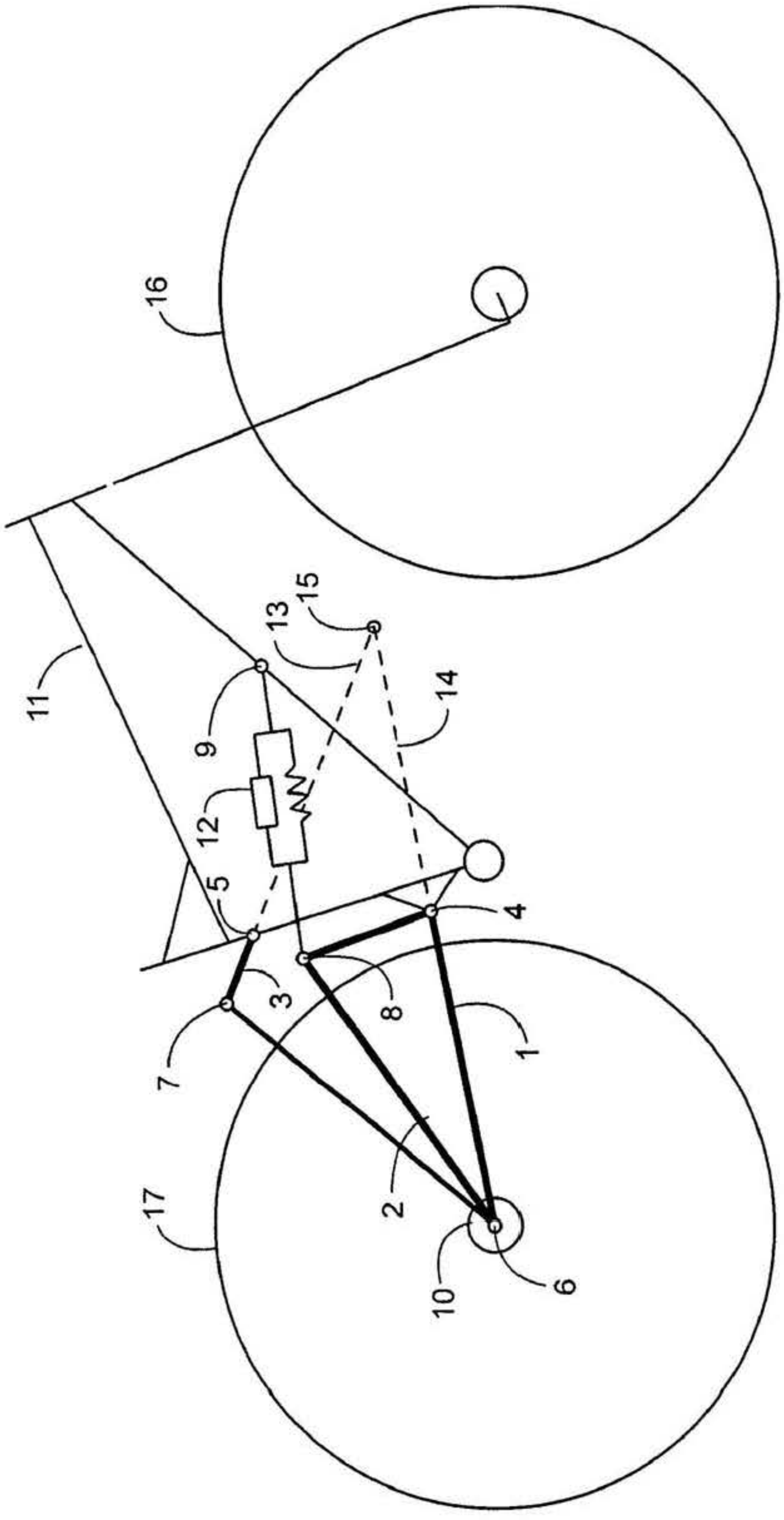

FIGURE 15

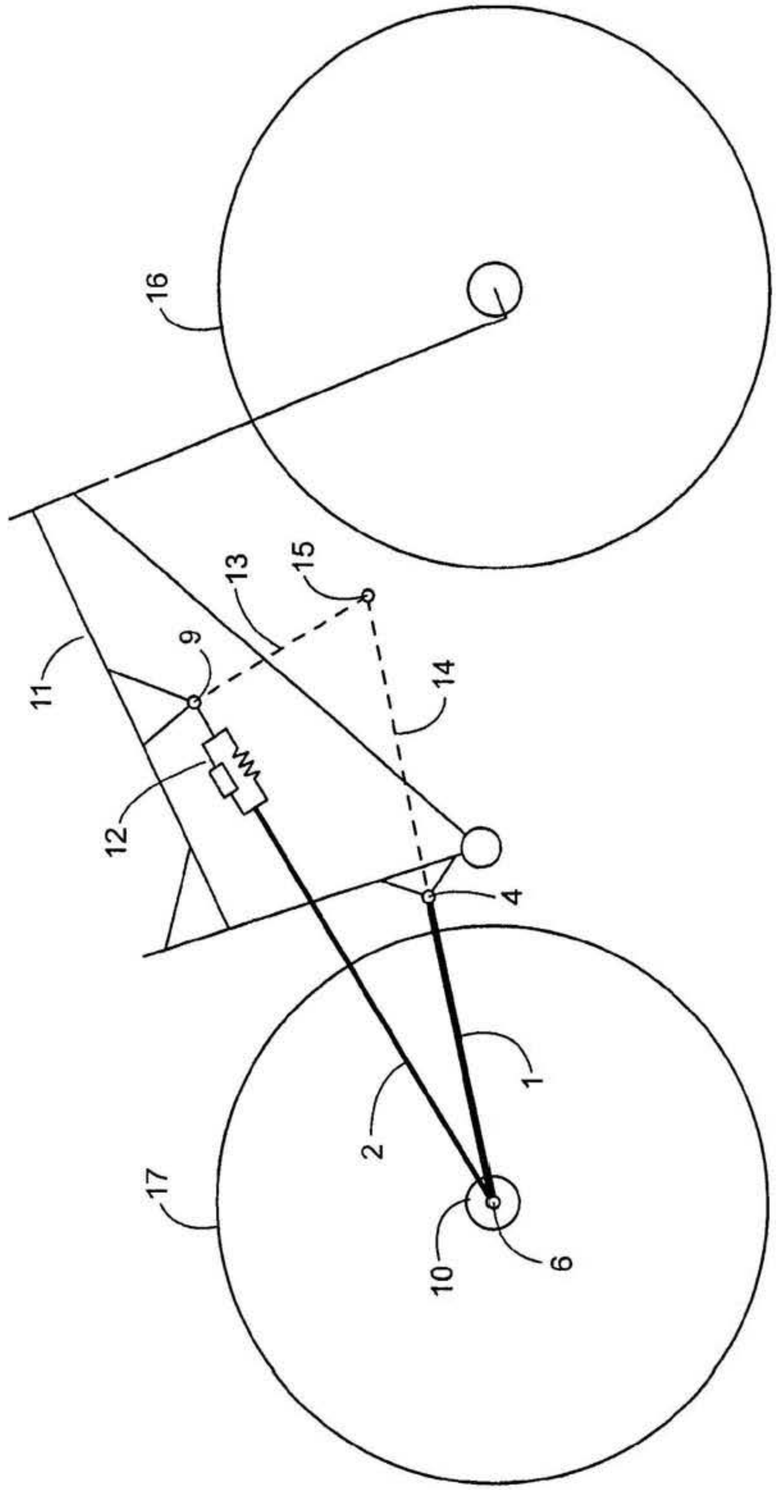

FIGURE 16

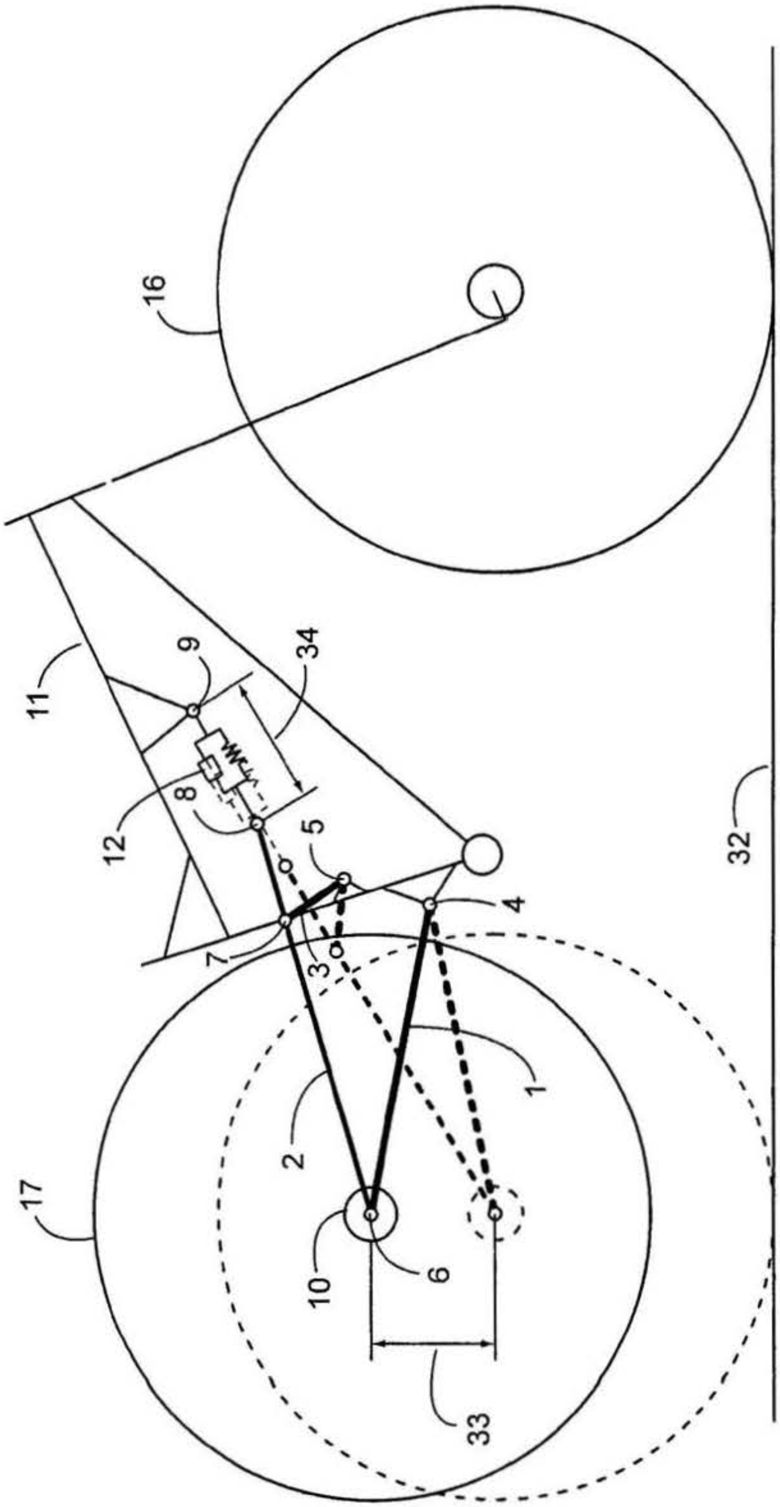

FIGURE 17

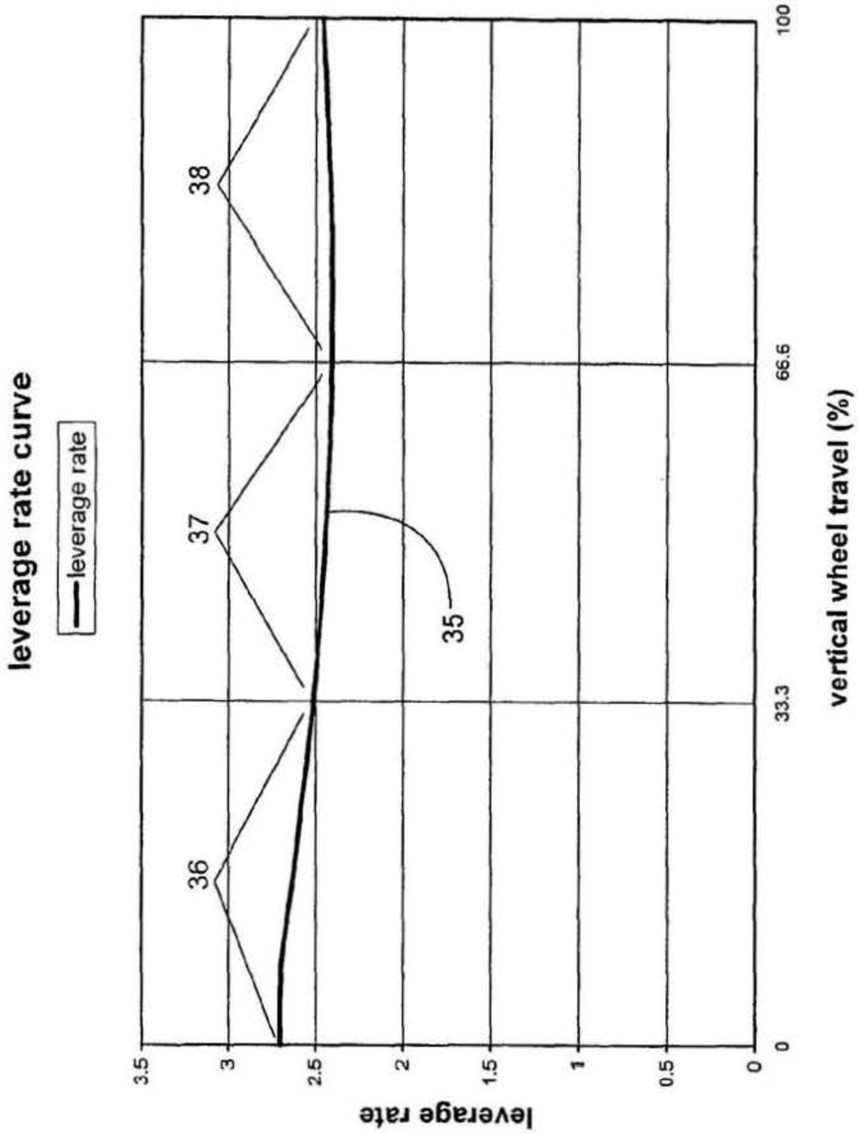
leverage rate curve
leverage rate
leverage rate
3.5
3
2.5
2
1.5
1
0.5
0
0
33.3
66.6
100
vertical wheel travel (%)
36
37
38
35

FIGURE 18

VEHICLE SUSPENSION SYSTEMS FOR SEPERATED ACCELERATION RESPONSES

This application is a continuation-in-part of U.S. application Ser. No. 11/510,522 filed Aug. 25, 2006, now U.S. Pat. No. 7,717,212, which is incorporated herein by reference.

1.0 FIELD OF THE INVENTION

This invention relates to suspension systems capable of separating acceleration responses.

2.0 BACKGROUND

Automobiles, bicycles, motorcycles, all terrain vehicles, and other wheel driven vehicles are used for various purposes, including transportation and leisure. These vehicles are designed to use a power source to drive through a power transmission system to a wheel or wheels, which transfers rotary motion to the ground via tractive force between a wheel or wheels and the ground. Vehicles are also used to traverse even terrain like paved streets, and uneven terrain like off-road dirt trails. Off road trails are generally bumpier and allow for less wheel traction than paved roads. A bumpier terrain is best navigated with a vehicle that has a suspension system. A suspension system in a vehicle is aimed to provide a smoother ride for an operator or rider, and increase wheel traction over varied terrain. Vehicle suspension systems for the front wheel and for the back wheel are available. These vehicles have means of powered acceleration and deceleration. Powered acceleration can be achieved through machine or human power rotating a wheel through a mechanical arrangement. Deceleration can be achieved through the use of a braking system that mechanically impedes rotation of a wheel.

One undesirable effect of suspension systems is unwanted responses or suspension compression or extension during powered acceleration or deceleration. Acceleration and deceleration forces cause a suspension system to react in different ways. It is beneficial to rider comfort for a suspension to be designed to specifically recognize and respond to differing acceleration and deceleration forces. Complex systems using linkages or hydraulic means exist to reduce unwanted suspension movement that occurs during acceleration or deceleration. The drawback to these other systems is their complexity and associated cost. With more complex designs, more expensive manufacturing techniques are required to build them. Less complex systems are more cost effective, but do not allow for the separation of acceleration forces under powered acceleration and braking, which reduces suspension effectiveness, but allows a lower overall cost.

A need exists for suspension systems that can provide separated acceleration and deceleration responses while remaining cost effective to produce. The present invention provides new suspension systems for vehicles that can provide separated acceleration responses and that are cost effective.

3.0 SUMMARY OF THE INVENTION

The current invention relates to new suspension systems for vehicles, for example, bicycles, motorcycles, cars, SUVs, trucks, two wheel vehicles, four wheel vehicles, front wheel suspension vehicles, driven wheel suspension vehicles, and any other kind of vehicle with a suspension system. In certain embodiments of the invention, a suspension system of the invention can support a wheel using a link arrangement to

control suspension movement by manipulating braking forces present in the links during deceleration.

Suspension systems of the invention are useful for a variety of vehicles and preferably in human powered vehicles. Unwanted suspension movement can have a significant detrimental effect on rider performance and comfort. The need for a suspension system that can control suspension movement under acceleration and deceleration has therefore become more pressing. The present invention provides suspension system designs for vehicles that reduce unwanted suspension movements during acceleration and deceleration.

Certain embodiments of the invention can comprise a wheel suspension system where a wheel is connected to a wheel link. In certain embodiments, a braking arrangement intended to impede wheel rotation when needed is attached to a brake link. The brake link, in certain embodiments, may be attached to the wheel link through a pivoting or flexing connection concentric to the wheel rotation axis, and attached at another point through a pivoting or flexing connection to a control link. The brake link, in certain embodiments, can be attached to the wheel link through a pivoting and/or flexing connection, and in certain other embodiments the brake link is attached at another point through a pivoting and/or flexing connection to a control link. The control link and wheel link, in certain embodiments, each have a link force line. A link force line of a control link and a wheel link, in certain embodiments, intersect in a point called instant force center. The location of this instant force center, in certain embodiments, governs suspension reaction to deceleration as a result of braking.

Certain embodiments of the invention can comprise a shock absorber. A shock absorber, in certain embodiments, may be a damper, a spring, a compression gas spring, a leaf spring, a coil spring, or a fluid. In certain other embodiments, a shock absorber is mounted so that it is able to respond to movement of a rear wheel. In certain embodiments, a shock absorber is mounted to a brake link. In certain embodiments, a shock absorber is mounted to a control link. In certain embodiments, a shock absorber is mounted to a brake link and/or a control link in a pivotal manner, and preferably so that a force that compresses or extends the shock absorber is transmitted through a brake link or a control link.

4.0 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. **2** shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. **3** shows a side view of a bicycle using the wheel suspension system shown in FIG. **1**.

FIG. **4** shows a side view of a bicycle using the wheel suspension system shown in FIG. **2**.

FIG. **5** shows a three dimensional view of a bicycle using the wheel suspension system shown in FIG. **2** and FIG. **4**.

FIG. **6** shows a three dimensional view of a bicycle using the wheel suspension system shown in FIG. **2**, FIG. **4**, and FIG. **5**, with a cutaway view of a critical area.

FIG. **7** shows a three dimensional cutaway view of a wheel link pivot of a bicycle using the wheel suspension system shown in FIG. **2**, FIG. **4**, FIG. **5**, and FIG. **6**, with a cutaway view of a critical area according to certain embodiments of the invention.

FIG. 8 shows a three dimensional cutaway view of a wheel link pivot of a bicycle using the wheel suspension system shown in FIG. 2, FIG. 4, and FIG. 5, with a cutaway view of a critical area according to certain embodiments of the invention.

FIG. 9 shows a two dimensional cutaway view of a wheel link pivot of a bicycle using the wheel suspension system shown in FIG. 2, FIG. 4, and FIG. 5, with a cutaway view of a critical area according to certain embodiments of the invention.

FIG. 10 shows a side view of a wheel link floating pivot useful for bicycles and quick release type wheels according to certain embodiments of the current invention.

FIG. 11 shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. 12 shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. 13 shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. 14 shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. 15 shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. 16 shows a diagrammatical side view of a vehicle using a wheel suspension system that according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed state.

FIG. 17 shows a diagrammatical side view of a vehicle using a wheel suspension system according to certain embodiments of the current invention. The vehicle is shown with the wheel suspension system in an uncompressed and compressed state.

FIG. 18 shows a leverage rate curve graph according to certain embodiments of the invention.

5.0 DETAILED DESCRIPTION

Vehicles must be accelerated against their environment to propel an operator or rider across terrain. In order to accelerate these vehicles, a certain amount of energy must be exerted and transformed into rotary motion at a wheel or plurality of wheels. Suspended wheeled vehicle energy conversion types are widely varied. Some vehicles like bicycles, tricycles, and pedal cars use converted human energy as the drive unit. Other vehicles use electric motors or combustion engines, as their drive unit. These electric motors and combustion engines extract rotary motion through the controlled release of chemically stored energy.

Almost all vehicle types use some sort of rotary motion transmission system to transfer rotational force from a drive unit to a wheel or plurality of wheels. A simple bicycle or motorcycle or all terrain vehicle uses a chain or belt to transfer power from a drive unit to a wheel. These chain or belt drive transmissions typically use one sprocket in the front which is coupled to a drive system and one sprocket in the rear which is coupled to a wheel.

More complex bicycles, motorcycles, all terrain vehicles, and automobiles use a shaft drive system to transfer power from a drive system to a driven wheel or wheels. These shaft drive systems transfer power through a rotating shaft that is usually reasonably perpendicular to the driven wheel spinning axis, with power transferred to the driven wheel via a bevel, spiral bevel, hypoid, worm gear drivetrain, or some other means. These single sprocket chain and belt, and shaft driven vehicles can use a direct driven single speed arrangement, where drive unit output shaft speed and torque is transferred to the driven wheel at a constant unchanging ratio. These single sprocket chain and belt, and shaft driven vehicles can also use a commonly found multi speed arrangement, where drive unit output shaft speed and torque is transferred to the driven wheel at a variable ratio through operator selected or automatically selected ratio changing mechanisms.

A bicycle with a more advanced design includes gear changing systems that have clusters of selectable front chainrings and rear sprockets. These gear changing systems give the bicycle rider a selectable mechanical advantage for use during powered acceleration. The mechanical advantage selection, allows a rider spinning a front sprocket cluster via crank arms, to attain lower revolution speed and higher torque values, or conversely, higher revolution speed and lower torque values at a driven wheel.

The current invention, in certain embodiments, is directed at suspension systems for vehicles that can reduce unwanted suspension movement during braking deceleration, for example, a bicycle, a motorcycle, a car, an SUV, a truck, or any other kind of vehicle. Suspension systems of the current invention are useful for a large variety of vehicles, including, but not limited to, human powered vehicles, off road use vehicles with long displacement suspension, high efficiency road going vehicles, and other vehicles.

A vehicle suspension system isolates a vehicle chassis from forces imparted on the vehicle when traversing terrain by allowing the vehicle's ground contact points to move away from impacts at the terrain level and in relation to the vehicle chassis by a compressible suspension movement. The compressible suspension movement that isolates a chassis from these impacts is called suspension displacement or suspension travel. Compressible suspension travel has a beginning point where the suspension is in a completely uncompressed state (the suspension is uncompressed), and an ending point of displacement, where the suspension is in a completely compressed state (the suspension is fully compressed). Suspension travel displacement is measured in a direction parallel to and against gravity. As a suspension system using certain embodiments the invention is compressed, a shock absorber is compressed. As the shock absorber is compressed, the force output from the unit rises. Pivots of a suspension system of the invention are named after a component that connects with the pivot. A pivot may be fixed or floating. A fixed pivot maintains a position relative to the frame of the vehicle when the suspension is compressed. A floating pivot changes its position relative to the frame of the vehicle when the suspension is compressed. A suspended wheel has a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place. At the beginning of the wheel suspension travel distance, when the suspension is in a completely uncompressed state, the shock absorber is in a state of least compression, and the suspension is easily

compressed. As the suspended wheel moves compressively, shock absorber force at the wheel changes in relation to shock absorber force multiplied by a leverage ratio, where a leverage ratio is the ratio of compressive wheel travel change divided by shock absorber measured length change over an identical and correlating given wheel travel distance.

5.1 The Drawings Illustrate Examples of Certain Embodiments of the Invention

The Figures in this disclosure use the following numbers and terms; wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel (or hub) rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**); rear hub (**18**); brake mount (**19**); pivot bearing (**20**); pivot axle (**21**); thru axle (**22**); quick release lever (**23**); quick release mechanism (**24**); pivot axle nut (**25**); derailleur hanger (**26**); axle axial stop (**27**); release position (**28**); release clearance area (**29**); compression force (**30**); compression force distribution (**31**); ground plane (**32**); incremental vertical compression distance (**33**); shock absorber length (**34**); leverage rate curve (**35**); beginning ⅓ (**36**); middle ⅓ (**37**); end ⅓ (**38**).

FIG. **1** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **1** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **1**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **1**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The brake link **2** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **2** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **2** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **2**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **2**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link

fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The control link **3** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **3** presents a design as shown in FIG. **1** for a suspension according to certain embodiments of the current invention via a two-dimensional side view. FIG. **3** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **3** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**).

FIG. **4** presents a design as shown in FIG. **2** for a suspension according to certain embodiments of the current invention via a two-dimensional side view. FIG. **4** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **4** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**).

FIG. **5** presents a design as shown in FIGS. **2** and **4** for a suspension according to certain embodiments of the current invention via a three-dimensional view. FIG. **5** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **5** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); rear hub (**18**); brake mount (**19**). A frame **11** provides the structure for the vehicle. The frame **11** depicts a tubular structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. In the embodiment presented in FIG. **5**, the wheel link fixed pivot **4** comprises a clevis that is a structural component of the frame **11**, and a hitch to be received by the clevis, where the hitch is a structural component of the wheel link **1**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. The rear hub **18** is a structural component of the rear wheel **17** shown in FIGS. **1**, **2**, **3**, and **4**. The rear hub **17** and rear wheel **17** share a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. In the embodiment presented in FIG. **5**, the wheel link floating pivot **6** comprises a pair of clevis that is are structural components of wheel link **1**, and a pair of hitches to be received by the devises, where the hitches are structural components of the brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. In the embodiment presented in FIG. **5**, a disc brake caliper can be bolted to a brake mount **19**. The disc brake caliper will clamp on a disc brake rotor that is attached to the rear hub so that braking force can travel through the hub, through spokes or a wheel, to a tire and be transferred to the ground. Another design for the brake system is to use cantilever brakes or V-Brakes, where the brakes are mounted to the brake link **2** via posts that project from the brake link. The cantilever brakes or V-brakes then use a pad that can be clamped onto the wheel and slow the wheel down. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. In the embodiment presented in FIG. **5**, the control link **3** is shown as two separate parts that together control the brake link **2** movements. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The control link **3** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**.

FIG. **6** presents a design as shown in FIGS. **2**, **4**, and **5** for a suspension according to certain embodiments of the current invention via a three-dimensional view. FIG. **6** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **6** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); rear hub (**18**); brake mount (**19**). A cutaway view of the rear hub **18** and wheel link floating pivot **6** is shown for locational purposes for reference when viewing FIG. **7**.

FIG. **7** shows a three-dimensional cutaway view of a wheel link floating pivot **6** as shown in FIGS. **2**, **4**, **5** and **6** for a suspension according to certain embodiments of the current invention. FIG. **7** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **7** are the following: wheel link (**1**); brake link (**2**); wheel rotation axis (**10**); rear hub (**18**);

brake mount (**19**); pivot bearing (**20**); pivot axle (**21**); thru axle (**22**). Certain embodiments of the wheel link floating pivot **6** can comprise a pivot bearing **20**, which allows for the independent rotation of the brake link **2** and wheel link **1** around a hub rotation axis **10**. The rotation of the wheel link **1** and brake link **2** can be concentric to the hub rotation axis **10**. A pivot bearing **20** can be a singular or multiple of a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a flexure, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. A pivot axle **21** acts as a bearing surface for the pivot bearing **20**. The pivot axle **21** can comprise singular or multiple parts. The pivot axle **21** can have a hole through it where it can receive a thru axle **22**. The thru axle **22** can comprise singular or multiple parts. The thru axle **22** can be used to mount the rear hub **18** concentric to the wheel link floating pivot **6**, yet still allow removal of the rear hub **18** for convenience. A thru axle **22** can comprise a solid axle, a thru axle, a hollow axle, a QR, a quick release, a skewer, a quick release skewer, a through bolt, or other components intended to allow rear hub **18** rotation around a wheel rotation axis **10**. The rear hub **18** is shown as a solid part for simplicity of illustration, where in reality it rotates on ball bearings that allow independent rotation of the rear hub **18** and rear wheel in relation to the thru axle **22** and concentric to the wheel rotation axis **10**. A disc brake rotor can be attached to the rear hub **18** so that braking force can travel through the rear hub **18**, through spokes and or a wheel, to a tire and be transferred to the ground.

FIG. **8** shows a three-dimensional cutaway view of a wheel link floating pivot **6** for a suspension according to certain embodiments of the current invention. FIG. **8** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **8** are the following: wheel link (**1**); brake link (**2**); wheel rotation axis (**10**); rear hub (**18**); brake mount (**19**); pivot bearing (**20**); pivot axle (**21**); thru axle (**22**); quick release lever (**23**); quick release mechanism (**24**); pivot axle nut (**25**); derailleur hanger (**26**). Certain embodiments of the wheel link floating pivot **6** can comprise a pivot bearing **20**, which allows for the independent rotation of the brake link **2** and wheel link **1** around a hub rotation axis **10**. The rotation of the wheel link **1** and brake link **2** can be concentric to the hub rotation axis **10**. A pivot bearing **20** can be a singular or multiple of a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a flexure, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. A ball bearing configuration is shown in FIG. **8**, where ball bearings are used for the pivot bearing **20**. The pivot bearing **20** and the configuration illustrated in FIG. **8** could also alternatively or additionally use a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a flexure, a heim joint, a journal bearing, a tapered roller bearing, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. A pivot axle **21** acts as a bearing surface for the pivot bearing **20**. The pivot axle **21** can comprise singular or multiple parts. The pivot axle **21** can be a removable part as shown on the brake side in FIG. **8**, or the pivot axle **21** can be integrated into a link, such as a brake link **2** or a wheel link **1** as shown on the drive side in FIG. **8**. The pivot axle **21** can have a hole through it where it can receive a thru axle **22**. A pivot axle nut **25** is used to concurrently affix the brake link **2** and pivot bearing **20** to the pivot axle **21** and wheel link **1**. A derailleur hanger

26 is used to attach a derailleur drivetrain component to a bicycle and can be a removable part as shown in the current embodiment. In certain other embodiments, a derailleur hanger **26** can be integrated with a wheel link **1** or a brake link **2**. A brake mount **19** can be used to attach a brake to a brake link **2**. The thru axle **22** can comprise singular or multiple parts. The thru axle **22** can be used to mount the rear hub **18** concentric to the wheel link floating pivot **6**, yet still allow removal of the rear hub **18** for convenience. A thru axle **22** can comprise a solid axle, a thru axle, a hollow axle, a QR, a quick release, a skewer, a quick release skewer, a through bolt, or other components intended to allow rear hub **18** rotation around a wheel rotation axis **10**. A quick release thru axle in certain embodiments can comprise a quick release lever **23**, and or a quick release mechanism **24**. The quick release lever **23** is a mechanical lever that can be used to provide clamping force through a quick release mechanism **24** to clamp the rear hub **18** between the floating pivots **6** and or between a wheel link **1**, brake link **2**, pivot axle **21** or combination of wheel link **1** and brake link **2** and pivot axle **21**. A quick release mechanism can comprise a cam, a pivot, a taper, a thread, a bearing, a bushing, or other mechanical devices intended to develop a clamping force axial with the wheel rotation axis **10**. The thru axle **22** is connected to the wheel link **1** via a threaded connection on the drive (right) side. The thru axle **22** is screwed into the wheel link **1** on the drive side and when snug a quick release mechanism **24** is used to axially fix the hub **18**. The rear hub **18** is shown as a solid part for simplicity of illustration, where in reality it rotates on ball bearings that allow independent rotation of the rear hub **18** and rear wheel in relation to the thru axle **22** and concentric to the wheel rotation axis **10**. A disc brake rotor can be attached to the rear hub **18** so that braking force can travel through the rear hub **18**, through spokes and or a wheel, to a tire and be transferred to the ground.

FIG. **9** shows a two-dimensional rear sectional view of a wheel link floating pivot **6** for a suspension according to certain embodiments of the current invention. FIG. **9** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **9** are the following: wheel link (**1**); brake link (**2**); wheel rotation axis (**10**); brake mount (**19**); pivot bearing (**20**); pivot axle (**21**); compression force (**30**); compression force distribution (**31**). Certain embodiments of the wheel link floating pivot **6** can comprise a pivot bearing **20**, which allows for the independent rotation of the brake link **2** and wheel link **1** around a hub rotation axis **10**. The rotation of the wheel link **1** and brake link **2** can be concentric to the hub rotation axis **10**. A pivot bearing **20** can be a singular or multiple of a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a flexure, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. A ball bearing configuration is shown in FIG. **9**, where ball bearings are used for the pivot bearing **20**. The pivot bearing **20** and the configuration illustrated in FIG. **9** could also alternatively or additionally use a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a flexure, a heim joint, a journal bearing, a tapered roller bearing, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. A pivot axle **21** acts as a bearing surface for the pivot bearing **20**. The pivot axle **21** can comprise singular or multiple parts. The pivot axle **21** can be a removable part as shown on the brake side in FIG. **9**, or the pivot axle **21** can be integrated into a wheel link **1** or brake link **2**. The

pivot axle **21** can have a hole through it where it can receive a thru axle **22**. A brake mount **19** can be used to attach a brake to a brake link **2**. The structural configuration presented in FIG. **9** presents several useful embodiments that improve performance of the system without a gain in cost. A brake link **2** in a bicycle can be loaded in compression during suspension compression. A brake link **2** can be constructed so that the brake link **2** is angled so that the end of the brake link **2** nearest to the wheel link floating pivot **6** is farther from the center plane of the frame than the other end of the brake link **2**. During suspension compression, the compression force **30** pushes downward and outward, trying to push the floating pivots **6** or floating ends of the wheel link **1** away from each other. Compression force **30** is transmitted from the brake link **2** into the pivot bearing **20**. The compression force **30** is shown being transmitted as a compression force distribution **31** into the outer race of the pivot bearing **20**, but it should be understood that the bearing could be supported in the opposite manner so that the compression force distribution **31** could pass through the inner race of the pivot bearing **20** to achieve the same desired end result. In certain preferred embodiments, the pivot bearing **20** is supported radially by a pivot axle **21**, and axially by a wheel link **1**. By supporting the pivot bearing **20** inner race axially with the wheel link 1, the possibility of failure during use through the accidental loosening of a pivot axle **21** is reduced. Alignment of the brake mount **19** with the hub **18** is also improved through the reduction of tolerance stackup presented in the current embodiment. The pivot bearing **20**, in certain embodiments could be supported axially by a pivot axle **21**. The pivot axle **21** installs from the hub **18** side of the wheel link **1**. The brake link **2** installs on the hub **18** side of the wheel link **1**. In certain embodiments, the pivot axle **21**, brake link **2** could install on the side of the wheel link **1** opposite of the hub **18**.

FIG. **10** shows a side view of a wheel link floating pivot **6** for a suspension according to certain embodiments of the current invention. FIG. **10** shows a representation of a frame structure and a suspension of the invention that could be used in a bicycle application. Shown in FIG. **10** are the following: wheel link (**1**); brake link (**2**); wheel rotation axis (**10**); pivot bearing (**20**); derailleur hanger (**26**); axle axial stop (**27**); release position (**28**); release clearance area (**29**). Certain embodiments of the wheel link floating pivot **6** can comprise a pivot bearing **20**, which allows for the independent rotation of the brake link **2** and wheel link **1** around a hub rotation axis **10**. The rotation of the wheel link **1** and brake link **2** can be concentric to the hub rotation axis **10**. A pivot bearing **20** can be a singular or multiple of a bushing, a DU bushing, a DX bushing, an IGUS bushing, a bearing, a ball bearing, a needle bearing, a roller bearing, a tapered roller bearing, a flexure, or other components intended to allow independent movement of the wheel link **1** and brake link **2** in at least one degree of freedom. In certain embodiments, a brake link **2** fixes a hub **18** and derailleur hanger **26** in position through a quick release vertical style dropout. In certain other embodiments, a wheel link **1** can fix a hub **18** and derailleur hanger **26** in position through a quick release vertical style dropout. An axle axial stop **27** is connected to a quick release mechanism, hub **18**, or thru axle **22**. The axle axial stop **27** provides means for quicker removal of a wheel. The axle axial stop **27** is tightened towards a hub **18** clamping a wheel link **1** or brake link **2** as illustrated in FIG. **10**. The axle axial stop **27** is clamped in an upper position or clamped position when the suspension system or vehicle is in use. A release clearance area **29** is provided adjacent to the axle axial stop **27** and wheel rotation axis **10**. When wheel removal is desired, clamping force on the axle axial stop **27** can be removed via the quick release mechanism or other means, and the axle axial stop **27** can be moved to the release position **28**. Once the axle axial stop **27** is at the release position **28**, the wheel can be freely moved in an axial direction to facilitate removal from the wheel link **1** or brake link **2**.

FIG. **11** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **11** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **11**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **11**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The control link **3** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the wheel link **1** via a second shock pivot **9**. The movement of the first shock pivot **8** and second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces.

The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **12** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **12** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **12**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **12**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The brake link **2** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **13** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **13** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **13**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **13**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The control link **3** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **14** presents a design for a suspension according to certain embodiments of the current invention via a two-di-

mensional side view. Shown in FIG. **14** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **14**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **14**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The wheel link **1** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. The shock absorber **12** is mounted in a configuration that allows the second shock pivot **9** to mount behind a wheel link fixed pivot **4**. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **15** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **15** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **15**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **15**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The wheel link **1** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The shock absorber **12** is mounted in a configuration that allows the second shock pivot **9** to mount in front of a wheel link fixed pivot **4**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects through the control link fixed pivot **5** and control link floating pivot **7**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **16** presents a design for a suspension according to certain embodiments of the current invention via a two-di-

mensional side view. Shown in FIG. **16** are the following: wheel link (**1**); brake link (**2**); wheel link fixed pivot (**4**); wheel link floating pivot (**6**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); control link force line (**13**); wheel link force line (**14**); instant force center (**15**); front wheel (**16**); rear wheel (**17**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **16**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **16**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. According to certain embodiments of the current invention, a shock absorber **12** functions a control link **3**. A shock absorber **12**, in some embodiments, functions in the same manner as an infinitely long control link **3** would. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the shock absorber **12** and wheel link **1**. The brake link **2** is fixedly attached to a shock absorber **12** which allows for brake link articulation in at least one degree of freedom as defined by the wheel link floating pivot **6** and the second shock pivot **9**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. Force is transmitted through the links and shock absorber **12** via the link fixed and floating pivots **4**, and **6**, and second shock pivot **9**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. The second shock pivot **9** forces the brake link **2** to move in a prescribed manner. Brake link **2** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. A control link force line **13** projects in a perpendicular direction to the brake link **2** through the second shock pivot **9**. A wheel link force line **14** projects through the wheel link fixed pivot **4** and the wheel link floating pivot **6**. The intersection of the control link force line **13** and wheel link force line **14** is a measurable location called the instant force center **15**. The tactical location of the instant force center **15** can be used to control how the suspension system reacts to braking forces. The instant force center **15** location does not govern the suspension's reaction to powered acceleration.

FIG. **17** presents a design for a suspension according to certain embodiments of the current invention via a two-dimensional side view. Shown in FIG. **17** are the following: wheel link (**1**); brake link (**2**); control link (**3**); wheel link fixed pivot (**4**); control link fixed pivot (**5**); wheel link floating pivot (**6**); control link floating pivot (**7**); first shock pivot (**8**); second shock pivot (**9**); wheel rotation axis (**10**); frame (**11**); shock absorber (**12**); front wheel (**16**); rear wheel (**17**); ground plane (**32**); incremental vertical compression distance (**33**); shock absorber length (**34**). A frame **11** provides the structure for the vehicle. The frame **11** is shown as a series of lines that depict a structural layout for a vehicle such as a bicycle or motorcycle. The frame **11** provides a support or mounting location for powertrain components such as; engines, gears, transmissions, and fuel tanks; suspension parts such as forks, rear suspension and front suspension; operator interfaces such as handlebars and seats; and accessories such as water bottles and batteries for lights. A wheel link **1** is mounted to the frame **11** via a wheel link fixed pivot **4**. The wheel link fixed pivot **4** is a mounting location which allows for wheel link **1** articulation in at least one degree of freedom. The wheel link fixed pivot **4** and all other pivoting locations are shown as small circles in FIG. **17**. The wheel link **1** holds a wheel link fixed pivot **4** and a wheel link floating pivot **6** at a fixed distance apart from each other. The wheel link **1** allows the rear wheel **17** to articulate around the wheel link fixed pivot **4** at a constant or close to constant radius. Two wheels, a front wheel **16** and a rear wheel **17** are shown in FIG. **17**. The rear wheel **17** has a wheel rotation axis **10** which is concentrically located to the wheel link floating pivot **6**. The wheel floating link pivot **6** pivotally connects the wheel link **1** to a brake link **2**. A brake caliper or cantilever brake or V-brake is attached to the brake link **2** so that an operator can slow the vehicle. The rear wheel **17** will have a disc brake rotor or rotary braking surface attached so that the brake caliper or cantilever brake can slow the rear wheel **17**. Force from the brake will be transferred directly into the brake link **2**, and the brake link **2** will transmit force to the frame **11** via the control link **3** and wheel link **1**. Force is transmitted through the links via the link fixed and floating pivots **4**, **5**, **6**, and **7**. The brake link **2** can consist of a single sided strut that passes next to only one side of a rear wheel **17**, or a double sided strut that passes next to both sides of a rear wheel **17**. A control link **3** is attached to the frame **11** at a control link fixed pivot **5**. The control link fixed pivot **5** is a mounting location which allows for control link **3** articulation in at least one degree of freedom. The brake link **2** is attached to a control link **3** via a control link floating pivot **7**. The control link floating pivot **7** forces the brake link **2** to move in a prescribed manner. The brake link **2** is attached to a shock absorber **12** via a first shock pivot **8**. The shock absorber **12** is mounted to the frame **11** via a second shock pivot **9**. The movement of the first shock pivot **8** and stationary location of the second shock pivot **9** causes the shock absorber **12** to change length as the suspension is moved to a state of full compression. This length is called the shock absorber length **34** and is measured as the shortest distance between the first shock pivot **8** and the second shock pivot **9**. As a wheel is compressed, incremental vertical compression distance **33** measurements are taken. Incremental vertical compression distance **33** is measured perpendicular to gravity and a ground plane **32**. These incremental vertical measurements are called the incremental vertical compression distance **33**. A shock absorber length **34** can be changed by a wheel link **1**, and/or brake link **2**, and/or control link **3** movements as the suspension compresses. At each incremental vertical compression distance **33** measurement, a shock absorber length **34** measurement is taken. The relationship between incremental vertical compression distance **33** change and shock absorber length **34** change for correlating points in the suspension's compression is called leverage ratio, leverage rate, motion ratio or motion rate.

FIG. 18 illustrates a leverage rate curve according to certain embodiments of the current invention. A leverage rate curve 35 is a graphed quantifiable representation of leverage rate versus wheel compression distance or percentage of full compression. Wheel compression distance or vertical wheel travel is measured perpendicular to gravity with the initial 0 percent measurement taken at full suspension extension with the vehicle unladen and on even ground. As a suspension is compressed from a point of full extension to a point of full compression at a constant rate, measurements of shock absorber length are taken as the shortest distance between a first shock pivot and a second shock pivot at equal increments of shock absorber compression. When graphed as a curve on a Cartesian graph, leverage rate is shown on the Y axis escalating from the x axis in a positive direction, and vertical wheel travel is shown on the X axis escalating from the Y axis in a positive direction. Leverage rates of the current invention are designed, in certain embodiments, to achieve a desired force output at a wheel. In certain embodiments a leverage rate curve 35 can be broken down into three equal parts in relation to wheel compression distance or vertical wheel travel, a beginning ⅓, 36, a middle ⅓, 37, and an end ⅓, 38.

5.2 Wheel Links of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link, or two, three, four, five or more wheel links. A wheel link, in certain embodiments, is connected to a frame, a shock absorber, a first shock pivot, a second shock pivot, a wheel link floating pivot and/or a wheel link fixed pivot. In certain embodiments, a wheel link is located below (in other words, closer to the ground than) a brake link, a control link floating pivot, a control link, a first shock pivot, a shock absorber, an instant force center and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a suspension system of the invention comprises a wheel link that is the same length or about the same length as a brake link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a wheel link that is 5 percent or about 5 percent longer or shorter than a brake link of that suspension system, or 10 percent or about 10 percent longer or shorter, or 20 percent or about 20 percent longer or shorter, or 30 percent or about 30 percent longer or shorter, or 5 to 20 percent longer or shorter, or 5 to 50 percent longer or shorter, or 5 to 100 percent longer or shorter, or 5 to 200 percent longer or shorter, or 5 to 500 percent longer or shorter. In certain other embodiments, a wheel link of the invention is 2 to 50 centimeters (cm) in length, or 30 to 45 cm, or 35 to 40 cm. In certain other embodiments, a suspension system of the invention comprises a wheel link that is the same diameter or about the same diameter as a brake link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a wheel link that is 5 percent or about 5 percent larger or smaller in diameter than a brake link of that suspension system, or 10 percent or about 10 percent larger or smaller in diameter, or 20 percent or about 20 percent larger or smaller in diameter, or 30 percent or about 30 percent larger or smaller in diameter, or 5 to 20 percent larger or smaller in diameter. In certain other embodiments, a wheel link of the invention is 0.5 to 5 cm in diameter, or 1 to 4 cm, or 1.5 to 3 cm, or 2 to 2.5 cm.

5.3 Brake Links of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a brake link, or two, three, four, five or more brake links. A brake link, in certain embodiments, is connected to a wheel link floating pivot, a control link floating pivot, and/or a first shock pivot, and/or a second shock pivot. In certain embodiments, a brake link is located above (in other words, further from the ground than) a wheel link of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a brake link is located below (in other words, closer to the ground than) a control link floating pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a suspension system of the invention comprises a brake link that is the same length or about the same length as a wheel link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a brake link that is 5 percent or about 5 percent longer or shorter than a wheel link of that suspension system, or 10 percent or about 10 percent longer or shorter, or 20 percent or about 20 percent longer or shorter, or percent or about 30 percent longer or shorter, or 5 to 20 percent longer or shorter, or 5 to 50 percent longer or shorter, or 5 to 100 percent longer or shorter, or 5 to 200 percent longer or shorter, or 5 to 500 percent longer or shorter. In certain other embodiments, a brake link of the invention is 2 to 100 cm in length, or 35 to 55 cm, or 40 to 50 cm. In certain other embodiments, a suspension system of the invention comprises a brake link that is the same diameter or about the same diameter as a wheel link of that suspension system. In certain other embodiments, a suspension system of the invention comprises a brake link that is 5 percent or about 5 percent larger or smaller in diameter than a wheel link of that suspension system, or 10 percent or about 10 percent larger or smaller in diameter, or 20 percent or about 20 percent larger or smaller in diameter, or 30 percent or about 30 percent larger or smaller in diameter, or 5 to 20 percent larger or smaller in diameter. In certain other embodiments, a brake link of the invention is 0.5 to 5 cm in diameter, or 1 to 4 cm, or 1.5 to 3 cm, or 2 to 2.5 cm.

In certain other embodiments, a brake link and a wheel link of a suspension system of the invention are arranged relative to each other in a non-parallel manner when observed from side of the vehicle comprising the suspension system. In certain embodiments, a brake link and a wheel link are arranged relative to each other at an angle of 0 to 150 degrees, or 0 to 100 degrees, or 0 to 80 degrees, or 10 to 60 degrees, or 15 to 40 degrees, or 20 to 30 degrees, when observed from the side of the vehicle, while the suspension of said vehicle is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a brake link passes on a side of a frame member or on two sides of a frame member.

5.4 Control Links of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link, or two, three, four, five or more control links. A control link of a suspension system of the invention, in certain embodiments, is connected

to a brake link. In certain other embodiments, a control link is connected to a control link floating pivot, a brake link, a control link fixed pivot, a shock absorber, first shock pivot, and/or a second shock pivot. In certain other embodiments, a control link passes on a side of a frame member or on two sides of a frame member. In certain embodiments, a control link is located above a wheel link, a wheel link floating pivot, a wheel link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link fixed pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a control link is located below a control link floating pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link of the invention is 0.5 to 5 cm in diameter, or 1 to 4 cm, or 1.5 to 3 cm, or 2 to 2.5 cm. In certain other embodiments, a suspension system of the invention comprises a control link with a length that is 2 percent or about 2 percent of the length of a wheel link of that suspension system, or 5 percent or about 5 percent longer or shorter, or 10 percent or about 10 percent longer or shorter, or 20 percent or about 20 percent longer or shorter, or 30 percent or about 30 percent longer or shorter, or 2 to 20 percent longer or shorter, or 2 to 50 percent longer or shorter, or 2 to 100 percent longer or shorter, or 2 to 200 percent longer or shorter, or 2 to 500 percent longer or shorter. In certain other embodiments, a control link of the invention is 1 to 50 cm in length, or 2 to 25 cm, or 8 to 15 cm.

5.5 Wheel Link Fixed Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link fixed pivot, or two, three, four, five or more wheel link fixed pivots. In certain embodiments, a wheel link fixed pivot of a suspension system of the invention is located below a control link floating pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link, a control link fixed pivot, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a wheel link fixed pivot of a suspension system of the invention is located above a second shock pivot, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.6 Control Link Fixed Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link fixed pivot, or two, three, four, five or more control link fixed pivots. In certain embodiments, a control link fixed pivot of a suspension system of the invention is located below a control link floating pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a control link fixed pivot of a suspension system of the invention is located above a second shock pivot, a wheel link floating pivot, a wheel link fixed pivot, a wheel link, a brake link, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.7 Wheel Link Floating Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link floating pivot, or two, three, four, five or more wheel link floating pivots. In certain embodiments, a wheel link floating pivot of a suspension system of the invention is concentric with a wheel rotation axis of the vehicle, preferably the wheel rotation axis of a driven wheel, a rear wheel, a front wheel, or a suspended wheel of the vehicle. In certain other embodiments, a wheel link floating pivot is nearly concentric with a wheel rotation axis of the vehicle, preferably the wheel rotation axis of a driven wheel, a rear wheel, a front wheel, or a suspended wheel of the vehicle. A wheel link floating pivot is nearly concentric with a wheel rotation axis if the axis the pivot turns around is within 2 cm of the wheel rotation axis, or within 5 cm, or within 10 cm, or within 15 cm, or when the wheel axis and pivot axis are from 2 to 20 cm away from each other, or from 5 to 15 cm, or from 5 to 10 cm.

In certain embodiments, a wheel link floating pivot of a suspension system of the invention is located below a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a wheel link floating pivot of a suspension system of the invention is located above a wheel link, a wheel link fixed pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.8 Control Link Floating Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link floating pivot, or two, three, four, five or more control link floating pivots. In certain embodiments, a control link floating pivot of a suspension system of the invention is located below a control link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, a control link, a wheel link floating pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a control link floating pivot of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link, a first shock

pivot, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.9 First Shock Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a first shock pivot, or two, three, four, five or more first shock pivots. In certain embodiments, a first shock pivot of the invention can be connected to a brake link, a control link, a wheel link, a frame, a control link floating pivot, a control ink fixed pivot, a wheel link floating pivot, a wheel link fixed pivot, and/or share mounting with an other pivot. In certain embodiments, a first shock pivot of a suspension system of the invention is located below a control link floating pivot, a control link fixed pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a first shock pivot of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.10 Second Shock Pivots of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a second shock pivot, or two, three, four, five or more second shock pivots. In certain embodiments, a second shock pivot of the invention can be connected to a brake link, a control link, a wheel link, a frame, a control link floating pivot, a control ink fixed pivot, a wheel link floating pivot, a wheel link fixed pivot, and/or share mounting with an other pivot. In certain embodiments, a second shock pivot of a suspension system of the invention is located below a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a shock absorber, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a second shock pivot of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a shock absorber, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.11 Wheel Rotation Axis of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel rotation axis, or two or more wheel rotation axes. In certain embodiments, a wheel rotation axis of a suspension system of the invention is concentric with a wheel link floating pivot of the vehicle, preferably the wheel rotation axis of a rear wheel of the vehicle. In certain other embodiments, a wheel rotation axis is nearly concentric with a wheel link floating pivot of the vehicle. A wheel rotation axis is nearly concentric with a wheel link floating pivot if the axis the pivot turns around is within 2 cm of the wheel rotation axis, or within 5 cm, or within 10 cm, or within 15 cm, or when the wheel axis and pivot axis are from 2 to 20 cm away from each other, or from 5 to 15 cm, or from 5 to 10 cm.

In certain embodiments, a wheel rotation axis of a suspension system of the invention is located below a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a wheel rotation axis of a suspension system of the invention is located above a wheel link, a wheel link fixed pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.12 Shock Absorbers of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a shock absorber, or two, three, four, five or more shock absorbers. A shock absorber, in certain embodiments, may be a damper, a spring, a compression gas spring, a leaf spring, a coil spring, or a fluid. A shock absorber, in certain embodiments may comprise a fist shock pivot, a second shock pivot, a body, a shaft, a spring, an air spring, a gas spring, a bushing, a shaft axial movement, a shock length, a strut, and/or a piston. A shock absorber can be called a shock absorber, a shock, a spring damper unit, a spring, a damper, an energy converter, and/or a heat converter. In certain embodiments of the invention a shock absorber can be compressed or extended as the suspension moves towards a state of full compression. In certain embodiments, a shock absorber can be compressed at a constant or variable rate as the suspension moves towards a state of full compression. As a wheel is compressed, incremental vertical compression distance measurements are taken. Incremental vertical compression distance is measured perpendicular to gravity and a ground plane. These incremental vertical measurements are called the incremental vertical compression distance. A shock absorber length can be changed by a wheel link, and/or brake link, and/or control link movements as the suspension compresses. At each incremental vertical compression distance measurement, a shock absorber length measurement is taken. The relationship between incremental vertical compression distance change and shock absorber length change for correlating points in the suspension's compression is called leverage ratio, leverage rate, motion ratio or motion rate. A leverage rate curve is a graphed quantifiable representation of leverage rate versus wheel compression distance or percentage of full compression. Leverage rates and creation of leverage rate curves are discussed and shown in Section 5.18 and FIG. **18**. A shock absorber has a measured shock length. A shock length can also be called length and is measured as the

shortest straight line distance between a first shock pivot and second shock pivot. A spring in a shock absorber can have a spring rate defined as the amount of force output at a given shock length. As a shock length is changed, spring force changes. This change can be graphed as spring rate. A spring found in a shock absorber can have a spring rate that varies or is constant as the shock absorber is compressed at a constant rate. In certain embodiments, a shock absorber of a suspension system of the invention is located below a control link floating pivot, a control link fixed pivot, a first shock pivot, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a shock absorber of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a first shock pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a shock absorber of a suspension system of the invention is located in front of a control link floating pivot, a control link fixed pivot, a first shock pivot, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, a shock absorber of a suspension system of the invention is located behind a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link fixed pivot, a control link floating pivot, a control link, a first shock pivot, a second shock pivot, and/or an instant force center, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.13 Control Link Force Lines of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a control link force line, or two, three, four, five or more control link force lines. In certain embodiments, a control link force line projects through a control link fixed pivot and a control link floating pivot of a suspension system of the invention. A control link force line, in certain embodiments, is parallel or substantially parallel to the ground, or at an angle of minus 60 to plus 60 degrees, or minus 45 to plus 45 degrees, or minus 30 to plus 30 degrees, or minus 15 to plus 15 degrees, or minus 10 to plus 10 degrees, or minus 5 to plus 5 degrees relative to the ground, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line descends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line ascends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line descends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 60 degrees, or 10 to 90 degrees, or 30 to 80 degrees, or 50 to 80 degrees, or 60 to 80 degrees, when the vehicle is on even ground when even ground is perpendicular to gravity and the suspension is fully compressed. In certain other embodiments, a control link force line projects from the rear to the front of the vehicle at an angle of −90 to 90 degrees, −50 to 50 degrees, 0 to 90 degrees, or 0 to 60 degrees, or 1 to 50 degrees, or 2 to 20 degrees, or 2 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a control link force line projects from the rearward in relation to the driven wheel at an angle of −90 to 90 degrees, −50 to 50 degrees, 0 to 90 degrees, or 0 to 60 degrees, or 1 to 50 degrees, or 2 to 20 degrees, or 2 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.14 Wheel Link Force Lines of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises a wheel link force line, or two, three, four, five or more wheel link force lines. In certain embodiments, a wheel link force line projects through a wheel link fixed pivot and a wheel link floating pivot of a suspension system of the invention. A wheel link force line, in certain embodiments, is parallel or substantially parallel to the ground, or at an angle of minus 60 to plus 60 degrees, or minus 45 to plus 45 degrees, or minus 30 to plus 30 degrees, or minus 15 to plus 15 degrees, or minus 10 to plus 10 degrees, or minus 5 to plus 5 degrees relative to the ground, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a wheel link force line descends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 30 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a wheel link force line ascends from the rear to the front of the vehicle at an angle of 0 to 90 degrees, or 0 to 50 degrees, or 0 to 30 degrees, or 0 to 20 degrees, or 0 to 10 degrees, or 5 to 15 degrees, or 10 to 20 degrees, or 20 to 30 degrees, when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain other embodiments, a wheel link force line descends from the rear to the front of the vehicle at an angle of 10 to 90 degrees, or 30 to 80 degrees, or 50 to 80 degrees, or 60 to 80 degrees, when the vehicle is on even ground when even ground is perpendicular to gravity and the suspension is fully compressed. In certain other embodiments, a wheel link force line projects from the rear to the front of the vehicle at an angle of −90 to 90 degrees, −50 to 50 degrees, −30 to 30 degrees, −15 to 45 degrees, −20 to 20 degrees, −10 to 10 degrees when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

5.15 Instant Force Centers of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises an instant force center, or two,

three, four, five or more instant force centers. An instant force is a point where a control link force line of a suspension system of the invention intersects with a wheel link force line of that suspension system. In certain other embodiments, a control link force line and a wheel link force line of a suspension system of the invention intersect when the suspension is uncompressed, when the suspension is fully compressed, and/or at any point of partial compression of the suspension system. In certain other embodiments, an instant force center of a suspension system of the invention is in different locations when the suspension is uncompressed and when the suspension is fully compressed. In certain embodiments, an instant force center of a suspension system of the invention is located above a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, an instant force center of a suspension system of the invention is located below a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, an instant force center of a suspension system of the invention is located behind a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity. In certain embodiments, an instant force center of a suspension system of the invention is located further to the front of the vehicle than a wheel link floating pivot, a wheel link, a brake link, a wheel link fixed pivot, a control link floating pivot, a control link, a control link fixed pivot, a first shock pivot, a shock absorber, and/or a second shock pivot, or any one or more of these components, of a suspension system according to the invention when the suspension is uncompressed and the vehicle is on even ground when even ground is perpendicular to gravity.

In certain embodiments of a suspension of the invention, an instant force center location is governed by the angle between and location of a wheel link and control link, and the closer to parallel a wheel link and control link are, the nearer to infinity is the instant force center perpendicular distance to the ground. In certain other embodiments, an instant force center of a suspension system of the invention has a first perpendicular distance from the ground, when the ground is level and perpendicular to gravity and when the suspension is uncompressed. In certain embodiments, an instant force center of a suspension system of the invention has a second perpendicular distance from the ground when the ground is level and perpendicular to gravity, when the suspension is compressed to a point further in the travel (in other words, partially to fully compressed), for example, when the suspension is 40 percent compressed, or 50 percent, or 60 percent, or fully compressed (in other words, 100 percent compressed). In certain other embodiments, the difference between the first perpendicular distance and second perpendicular distance can vary, for example, the difference may be from 0 to infinity, or to 10,000 meters (m), or 0 to 5000 m, or 0 to 2500 m, or 0 to 1000 m, or 0 to 100 m, or 0 to 10 m, or 0 to 0.5 m, or 0 to 0.2 m, 0 to 0.1 m.

5.16 Further Embodiments of the Invention

A vehicle using a suspension of the invention may, in certain embodiments, comprise a measurable suspension parameter, a link length or link lengths measured from the center of one link pivot to another, vehicle metrics, a frame, a moving suspension component, a pivot, a rotary motion device, a motion control device, and/or a power-train component.

A measurable suspension parameter and vehicle metrics, in certain embodiments, may comprise a wheelbase, track width, camber, caster, anti squat, pro squat, zero squat, squat, rake, trail, offset, fork offset, spindle offset, chainstay length, swingarm length, distance between driven wheel rotation axis and power unit output spindle axis, chain length, belt length, bottom bracket, bottom bracket offset, drive spindle, drive spindle offset, drive spindle height, wheel diameter, driven wheel diameter, driven wheel spindle height, chainstay slope, chainstay rise, center of mass, center of mass height, center of mass offset, center of mass offset from drive spindle, length, magnitude, top tube length, downtube length, front center distance, seat tube length, seatstay length, headset stack height, head tube angle, fork angle, impact angle, fork rake, crown rake, handlebar height, bar height, bar sweep, handlebar sweep, handlebar rise, bar rise, crank length, crank arm length, pitch diameter, gear pitch diameter, sprocket pitch diameter, cog pitch diameter, front gear pitch diameter, front sprocket pitch diameter, front cog pitch diameter, rear gear pitch diameter, rear sprocket pitch diameter, rear cog pitch diameter, first intermediate gear pitch diameter, second intermediate gear pitch diameter, first intermediate sprocket pitch diameter, second intermediate sprocket pitch diameter, first intermediate cog pitch diameter, second intermediate cog pitch diameter, instant center, instant force center, center of curvature, axle path, axle path center of curvature, moving center of curvature, forward moving center of curvature, forward moving instant center, rearward moving instant center, instant center movement direction change, center of curvature path, instant center path, instant center path focus, moving instant center path focus, virtual force center, virtual instant force center, virtual force center path, driving force, chain force, anti rotation force, sprocket force, bevel gear force, rotational force, driving force vector, chain pull, chain pull force, chain pull force vector, idler gear height, idler gear pitch diameter, idler cog pitch diameter, idler sprocket pitch diameter, jackshaft gear pitch diameter, jackshaft cog pitch diameter, jackshaft sprocket pitch diameter, leverage rate, leverage ratio, damper leverage rate, damper leverage ratio, spring leverage rate, spring leverage ratio, wheel motion ratio, wheel rate, spring rate, damping rate, leverage rate progression curve, leverage rate progression, progressive rate, regressive rate, straight rate, varying rate, suspension compression, full suspension compression, suspension extension, full suspension extension, droop travel, full droop travel, suspension ride height, static ride height, neighed ride height, laden ride height, weighted ride height, beginning of travel, middle of travel, end of travel, 0 percent travel to 20 percent travel, 20 percent travel to 80 percent travel, 80 percent travel to 100 percent travel, 0 percent travel to 25 percent travel, 25 percent travel to 75 percent travel, 75 percent travel to 100 percent travel, 0 percent travel to 30 percent travel, 30 percent travel to 65 percent travel, 65 percent travel to 100

percent travel, 0 percent travel to 35 percent travel, 35 percent travel to 60 percent travel, 60 percent travel to 100 percent travel, powertrain component rotation axis, driven wheel rotation axis, non driven wheel rotation axis, sprocket rotation axis, axis, axis location, rear wheel rotation axis, front wheel rotation axis, contact patch, tire contact patch, tire to ground contact patch, driven wheel tire to ground contact patch, non driven wheel tire to ground contact patch, front wheel tire to ground contact patch, rear wheel tire to ground contact patch, chain force vector, driving force vector, squat force vector, first carrier manipulation link force vector, second carrier manipulation link force vector, squat definition point, squat layout line, lower squat measurement definition line, measured squat distance, driven wheel axle path, driven wheel suspension travel distance, stable squat magnitude curve, defines a squat magnitude curve upper bound, a squat magnitude curve lower bound, instant force center, driven wheel rotation axis, chain force vector and driving force vector intersection point, driving cog rotation axis, center of the forward wheel tire to ground contact patch, center of the driven wheel tire to ground contact patch, vehicle center of sprung mass, 200 percent squat point, 200 percent measurement value, direction of gravity, squat magnitude definition point, squat magnitude, center of mass intersection vector, squat magnitude definition vector, percent squat magnitude variation, first squat magnitude curve slope, first squat magnitude curve slope, second squat magnitude curve slope, third squat magnitude curve slope, instant force center path, instant force center path focus, pitch diameter, driven idler cog rotation axis, instant force center position uncompressed, instant force center position compressed, instant force center movement, and/or an instant force center movement.

A frame, in certain embodiments, may be comprised of a solid beam, a solid bar, a metal bar, a plastic bar, a composite bar, a tube, a metal tube, an aluminum tube, a titanium tube, a steel tube, a composite tube, a carbon tube, a boron tube, an alloy tube, a magnesium tube, a stiff tube, a flexible tube, a thin walled tube, a thick walled tube, a butted tube, a single butted tube, a double butted tube, a triple butted tube, a quadruple butted tube, a straight gage tube, a round tube, a square tube, a rectangular tube, a rounded corner tube, a shaped tube, an aero tube, a streamline tube, a plus shaped tube, a bat shaped tube, a tube that transitions from a round tube to a rectangular tube, a tube that transitions from a round tube to a square tube, a tube that transitions from a round tube to a rounded corner tube, a tube that transitions from a round tube to a shaped tube, welding, MIG welding, TIG welding, laser welding, friction welding, a welded tube, a TIG welded tube, a MIG welded tube, a laser welded tube, a friction welded tube, a monocoque section, a monocoque frame, metal monocoque, TIG welded monocoque, MIG welded monocoque, laser welded monocoque, friction welded monocoque, carbon monocoque, Kevlar monocoque, fiberglass monocoque, composite monocoque, fiberglass, carbon fiber, foam, honeycomb, stress skin, braces, extrusion, extrusions, metal inserts, rivets, screws, castings, forgings, CNC machined parts, machined parts, stamped metal parts, progressive stamped metal parts, tubes or monocoque parts welded to cast parts, tubes or monocoque parts welded to forged parts, tubes or monocoque parts welded to machined parts, tubes or monocoque parts welded to CNC machined parts, glue, adhesive, acrylic adhesive, methacrylate adhesive, bonded panels, bonded tubes, bonded monocoque, bonded forgings, bonded castings, tubes bonded to CNC machined parts, tubes bonded to machined parts, tubes bonded to castings, tubes bonded to forgings, gussets, supports, support tubes, tabs, bolts, tubes welded to tabs, monocoque welded to tabs, tubes bolted to tabs, injection molded parts, seatstays, chainstays, a seatstay, a chainstay, a seat tube, seat tower, seatpost, seat, top tube, upper tube, downtube, lower tube, top tubes, down tubes, seat tube brace, and/or a seat tube support.

A moving suspension component of a suspension system of the invention, according to certain embodiments, may be comprised of a link, a wheel carrier link, a wheel carrier, a carrier manipulation link, an upper carrier manipulation link, lower carrier manipulation link, first carrier manipulation link, second carrier manipulation link, swingarm, swingarms, swinging arm, swinging arms, swing link, swing links, first link, second link, upper link, lower link, top link, bottom link, forward link, rearward link, front link, back link, primary link, secondary link, flexure, flexures, first flexure, second flexure, upper flexure, lower flexure, top flexure, bottom flexure, forward flexure, rearward flexure, front flexure, back flexure, primary flexure, secondary flexure, carrier manipulation flexures, sliders, curved sliders, straight sliders, complex curved sliders, carriers, tracks, curved tracks, straight tracks, complex curved tracks, bearings, cams, gears, seals, pivots, shock link, linkages, shock driving links, A-Arms, H-Arms, support arms, upper support, lower support, double arms, single arms, single pivot, multi pivot, SLA, Short Long Arm, hub carrier, wheel carrier, spindle, spindle carrier, wheel support, spindle support, trailing arm, semi-trailing arm, swingarm, double swingarm, parallel links, semi-parallel links, perpendicular links, strut, MacPherson strut, suspension strut, linear bearing, linear bushing, stanchion, fork, fork lower, 4-bar linkage, 5-bar linkage, 6-bar linkage, 7 bar linkage, 8 bar linkage, linkage, multi link, trackbar, panhard bar, watts link, watt link, ball joints, heim joint, radial joint, rotary joint, internal damper, external damper, enclosed damper, enclosed spring, caster block, camber block, caster wedge, driven wheel, vehicle chassis, first link fixed pivot, second link fixed pivot, first link floating pivot, second link floating pivot, driving cog, driven cog, forward wheel, driven idler cog, spring damper unit, first carrier manipulation track, second carrier manipulation track, first carrier manipulation slider, second carrier manipulation slider, first carrier manipulation slider pivot, second carrier manipulation slider pivot, stiffening link, and/or a stiffening linkage.

A pivot and a rotary motion devices of a suspension of the invention, according to certain embodiments, may be comprised of a pivot, a main pivot, a chainstay pivot, a seatstay pivot, an upper main pivot, a lower frame pivot, an upper frame pivot, a bottom frame pivot, a top frame pivot, a forward frame pivot, a rearward frame pivot, a front frame pivot, a rear frame pivot, a primary frame pivot, a secondary frame pivot, a tertiary frame pivot, a first frame pivot, a second frame pivot, a third frame pivot, a fourth frame pivot, combinations of pivots, bearing pivots, bushing pivots, bearings, bushings, seals, grease ports, greased pivots, oiled pivots, needle bearing pivots, journal bearing pivots, DU bearing pivots, plastic bushing pivots, plastic bearing pivots, a flexure, flexures, composite flexures, titanium flexures, aluminum flexures, steel flexures, aluminum pivot shafts, stainless steel pivot shafts, steel pivot shafts, titanium pivot shafts, plastic pivot shafts, composite pivot shafts, hardened bearing races, hardened pivot shafts, anodized pivot shafts, plated pivot shafts, coated pivot shafts, bearing caps, bearings seals, o-rings, o-ring seals, x-rings, and/or a x-ring seal.

A motion control device of a suspension of the invention, according to certain embodiments, may be comprised of a shock, a shock absorber, a spring damper unit, a damper, a spring, a coil spring, a leaf spring, a compression spring, an extension spring, an air spring, a nitrogen spring, a gas spring,

a torsion spring, a constant force spring, a flat spring, a wire spring, a carbon spring, a negative spring, a positive spring, a progressive spring, multiple springs, stacked springs, springs in series, springs in parallel, springs separate from a damper unit, a damper unit, hydraulics, hydraulic pistons, hydraulic valves, air valves, air cans, gears, cams, a cam, a gear, non-circular gears, linear damper, rotary damper, vane damper, friction damper, poppet valve, compensation spring, negative spring, elastomer, rubber bumper, bumper, progressive bumper, hydraulic bottoming bumper, pressure compensation, heat compensation, oil, water, damping fluid, cooling fluid, shims, pressure, shaft, through shaft, eyelet, adjusters, compensator, hose, reservoir, remote reservoir, low speed adjuster, high speed adjuster, mid range adjuster, bypass circuit, foot valve, large bump adjuster, small bump adjuster, high velocity adjuster, low velocity adjuster, hydraulic ram, hydraulic piston, active suspension, and/or a microprocessor.

A powertrain component of a suspension of the invention, according to certain embodiments, may be comprised of an energy storage device, a battery, fuel, a fuel tank, a flywheel, a liquid fuel, solid fuel, rocket fuel, a reactor, steam, a nuclear reactor, a fusion reactor, pressure, air pressure, hydraulic pressure, gas pressure, expanding gas, a motor, an electric motor, a hydraulic motor, a turbine motor, a steam turbine, a gas turbine motor, an engine, a gasoline engine, a diesel engine, diesel, gasoline, alcohol, sterling engine, a two stroke engine, a four stroke engine, miller cycle engine, ramjet engine, turbine engine, rocket engine, human power, horse power, animal power, potential energy, spring, compression spring, extension spring, constant force spring, progressive spring, power transfer components, wire, rope, string, chain, belt, shaft, gear, cog, cam, sprocket, pulley, lever, clutch, one way clutch, one way bearing, bearing, ball bearing, journal bearing, bushing, drive sprocket, driven sprocket, drive cog, driven cog, drive gear, driven gear, intermediate cog, intermediate sprocket, intermediate gear, idler cog, idler sprocket, idler gear, bottom bracket, bottom bracket spindle, crank arm, foot pedal, pedal, hand crank, cassette, sprocket cluster, derailleur, front derailleur, rear derailleur, chainguide, single ring chainguide, dual ring chainguide, multi ring chainguide, shifter, shift lever, shifter cable, shifter hose, hydraulic shifting, air shifting, pneumatic shifting, gearbox, transmission, continuously variable transmission, infinitely variable transmission, direct drive, tire, wheel, track, track segment, idler wheel, jet, driving cog, driven cog, forward wheel, driven idler cog.

Certain embodiments of the current invention may comprise a braking system which could further comprise disc brakes, calipers, disc caliper, hydraulic brakes, mechanical brakes, brake levers, brake hose, brake cable, brake pads, caliper brakes, rim brakes, V-brakes, cantilever brakes, friction brakes, wheel brake, mounting bolts, international brake standard mounting.

A suspension of the invention will comprise a linkage system which further comprise pivoting means concentric to a wheel rotation axis so that braking forces can be controlled by tactical placement of an instant force center, and so that acceleration forces can be controlled by the placement of a fixed pivot or pivots of a swinging wheel link.

5.17 Axles of Suspension Systems of the Invention

A suspension system of the current invention, in certain embodiments, comprises an axle. An axle can pass through a hub or fix a hub to a wheel link, brake link, dropout, vertical dropout, horizontal dropout, slot, hole, threaded hole or other axle attachment means. An axle can be a thru axle that passes through a hub, a quick release, QR, or other type of axle. An axle can be used to mount hub concentric to a wheel link floating pivot, yet still allow removal of the hub for convenience. A thru axle can comprise a solid axle, a thru axle, a hollow axle, a QR, a quick release, a skewer, a quick release skewer, a through bolt, or other components intended to allow hub rotation around a wheel rotation axis. A quick release in certain embodiments can comprise a thru axle, a skewer, a axle axial stop, a quick release lever, and or a quick release mechanism. The quick release lever is a mechanical lever or other means that can be used to provide clamping force through a quick release mechanism to clamp the rear hub between the floating pivots and or between a wheel link, brake link, pivot axle or combination of wheel link and brake link and pivot axle. A quick release mechanism can comprise a cam, a pivot, a taper, a thread, a bearing, a bushing, or other mechanical devices intended to develop a clamping force axial with the wheel rotation axis. The thru axle can be connected to the wheel link, for example, via a threaded connection on the drive (right) side or brake (left) side. The thru axle can be screwed into the wheel link or brake link and a quick release mechanism is used to axially clamp a hub.

5.18 Leverage Rate Curves of Suspension Systems of the Invention

A suspended wheel has a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place. At the beginning of the wheel suspension travel distance, when the suspension is in a completely uncompressed state, the shock absorber is in a state of least compression, and the suspension is easily compressed. As the suspended wheel moves compressively, shock absorber force at the wheel changes in relation to shock absorber force multiplied by a leverage ratio, where a leverage ratio is the ratio of compressive wheel travel change divided by shock absorber measured length change over an identical and correlating given wheel travel distance. Shock absorbers can output an increase in force for a compression or extension movement depending on the design of the shock absorber. In certain embodiments of the invention a shock absorber is compressed or extended as the suspension moves towards a state of full compression. A leverage rate curve is a graphed quantifiable representation of leverage rate versus wheel compression distance or percentage of full compression. Wheel compression distance or vertical wheel travel is measured perpendicular to gravity with the initial 0 percent measurement taken at full suspension extension with the vehicle unladen and on even ground. As a suspension of the invention is compressed from a point of full extension to a point of full compression at a constant rate, measurements of shock absorber length are taken as the shortest distance between a first shock pivot and a second shock pivot at equal increments of shock absorber compression. When graphed as a curve on a Cartesian graph, leverage rate is shown on the Y axis escalating from the x axis in a positive direction, and vertical wheel travel is shown on the X axis escalating from the Y axis in a positive direction. In certain embodiments, a shock absorber can be compressed at a constant or variable rate as the suspension moves towards a state of full compression. As a wheel is compressed, incremental vertical compression distance measurements are taken. Incremental vertical compression distance is measured perpendicular to gravity and a ground plane. These incremental

vertical measurements are called the incremental vertical compression distance. A shock absorber length can be changed by a wheel link, and/or brake link, and/or control link movements as the suspension compresses. At each incremental vertical compression distance measurement, a shock absorber length measurement is taken. The relationship between incremental vertical compression distance change and shock absorber length change for correlating points in the suspension's compression is called leverage ratio, leverage rate, motion ratio or motion rate. The measurement of force output at the wheel over travel is called wheel rate and is found by multiplying spring force times leverage rate at each increment of shock compression. Multiplying spring force times leverage rate at each increment of shock compression and graphing the values will output a quantifiable representation of spring force output at the rear wheel as the suspension is compressed, and this representation is useful for a designer or engineer to tactically plan a desired wheel rate. A spring in a shock absorber can have a spring rate defined as the amount of force output at a given shock length. As a shock length is changed, spring force changes. This change can be graphed as spring rate. A spring found in a shock absorber can have a spring rate that varies or is constant as the shock absorber is compressed at a constant rate. This constant or variable spring rate can be manipulated into a desired wheel rate by a tactically planned leverage rate. Leverage ratios of the current invention are designed to achieve a desired force output at a wheel. In certain embodiments a leverage rate curve can be broken down into three equal parts in relation to wheel compression distance or vertical wheel travel, a beginning ⅓ (third), a middle ⅓, and an end ⅓. In certain embodiments, a beginning ⅓ can comprise a positive slope, zero slope, and or a negative slope. In certain embodiments, a middle ⅓ can comprise a positive slope, zero slope, and or a negative slope. In certain embodiments, an end ⅓ can comprise a positive slope, zero slope, and or a negative slope. Certain preferred embodiments can comprise a beginning ⅓ with a positive slope, a middle ⅓ with a less positive slope, and an end ⅓ with a more positive slope. Certain preferred embodiments can comprise a beginning ⅓ with a negative slope, a middle ⅓ with negative and zero slope, and an end ⅓ with a positive slope. Certain preferred embodiments can comprise a beginning ⅓ with a positive and negative slope, a middle ⅓ with negative and zero slope, and an end ⅓ with a positive slope. Certain preferred embodiments can comprise a beginning ⅓ with a positive and negative slope, a middle ⅓ with negative and zero slope, and an end ⅓ with a more negative slope.

The present invention is not to be limited in scope by the specific embodiments described herein, which are intended as single illustrations of individual aspects of the invention, and functionally equivalent methods and components are within the scope of the invention. Indeed, various modifications of the invention, in addition to those shown and described herein, will become apparent to those skilled in the art from the foregoing description. Such modifications are intended to fall within the scope of the appended claims. Throughout this application the singular includes the plural and the plural includes the singular, unless indicated otherwise. All cited publications, patents, and patent applications are herein incorporated by reference in their entirety.

What is claimed is:

1. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a thru axle; wherein said thru axle is selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; wherein said rear hub is positioned between components selected from the group consisting of the wheel link, the brake link and a pivot axle, such that said rear hub is removable; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein said shock absorber is mounted to a link selected from the group consisting of the brake link and the control link, such that said shock absorber is able to respond to movement of a rear wheel; wherein said brake link is pivotally connected to a control link; and wherein as the suspension is compressed or extended, said shock absorber is compressed or extended, so that force that compresses or extends said shock absorber is transmitted through said brake link and said wheel link floating pivot; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

2. The suspension system of claim **1**, wherein force is transmitted to said shock absorber through said control link and a control link floating pivot.

3. The suspension system of claim **1**, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

4. The suspension system of claim **3**, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

5. The suspension system of claim **3**, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

6. The suspension system of claim **3**, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

7. The suspension system of claim **1**, said suspension system further comprising a removable pivot axle; wherein said removable pivot axle has a feature for positioning a rear hub in relation to said wheel rotation axis, wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt.

8. The suspension system of claim **1**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub, wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

9. The suspension system of claim **1**, wherein a said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

10. The suspension system of claim 1, wherein a said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

11. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, and a shock absorber; wherein said wheel link floating pivot is

concentric with said wheel rotation axis; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; and wherein said shock absorber is mounted to a link selected from the group consisting of the brake link and the control link, such that said shock absorber is able to respond to movement of a rear wheel; wherein said brake link is pivotally connected to said control link; wherein as the suspension is compressed or extended, said shock absorber is compressed or extended, so that force that compresses or extends said shock absorber is transmitted through said brake link and said wheel link floating pivot; wherein said suspension system comprises a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

12. The suspension system of claim **11**, wherein force is transmitted to said shock absorber through said control link and a control link floating pivot.

13. The suspension system of claim **11**, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

14. The suspension system of claim **13**, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

15. The suspension system of claim **13**, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

16. The suspension system of claim **13**, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

17. The suspension system of claim **11**, said suspension system further comprising a removable pivot axle; wherein said removable pivot axle has a feature for positioning a rear hub in relation to said wheel rotation axis, wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt.

18. The suspension system of claim **11**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

19. The suspension system of claim **11**, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

20. The suspension system of claim **11**, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

21. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a brake link, a control link floating pivot, a control link fixed pivot, a shock absorber, and a removable pivot axle; wherein the distance between said wheel link floating pivot and control link floating pivot is greater than the distance between said control link fixed pivot and control link floating pivot; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said wheel link is pivotally connected to said brake link; wherein said brake link is pivotally connected to said control link; wherein said removable pivot axle has a feature for positioning a rear hub in relation to said wheel rotation axis; wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, quick release skewer, and a through bolt; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein force is transmitted to said shock absorber through an element selected from the group consisting of a brake link, a control link, a wheel link fixed pivot, a control link floating pivot and a control link fixed pivot; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

22. The suspension system of claim **21**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

23. The suspension system of claim **21**, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

24. The suspension system of claim **21**, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

25. The suspension system of claim **21**, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

26. The suspension system of claim **21**, said suspension system further comprising a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; and wherein said rear hub is positioned between components selected from the group consisting of said wheel link, said brake link and a pivot axle, such that said rear hub is removable.

27. The suspension system of claim **21**, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

28. The suspension system of claim **21**, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

29. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a brake link, a control link floating pivot, a control link fixed pivot, and a shock absorber; wherein the distance between said wheel link floating pivot and control link floating pivot is greater than the distance between said control link fixed pivot and control link floating pivot; wherein said wheel link is pivotally connected to said brake

link; wherein said brake link is pivotally connected to said control link; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein force is transmitted to said shock absorber through an element selected from the group consisting of the brake link, the control link, a wheel link fixed pivot, the control link floating pivot and the control link fixed pivot; wherein said suspension system further comprises a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

30. The suspension system of claim **29**, said suspension system further comprising a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; and wherein said rear hub is positioned between components selected from the group consisting of the wheel link, the brake link and a pivot axle, such that said rear hub is removable.

31. The suspension system of claim **29**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

32. The suspension system of claim **29**, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

33. The suspension system of claim **29**, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

34. The suspension system of claim **29**, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

35. The suspension system of claim **29**, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

36. The suspension system of claim **29**, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

37. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a removable pivot axle; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said brake link is pivotally connected to said control link; wherein said removable pivot axle has a feature for positioning a rear hub in relation to said wheel rotation axis; wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein force is transmitted to said shock absorber through said brake link; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

38. The suspension system of claim **37**, wherein force is transmitted to said shock absorber through said control link, a wheel link fixed pivot, and a control link floating pivot.

39. The suspension system of claim **37**, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

40. The suspension system of claim **39**, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

41. The suspension system of claim **39**, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

42. The suspension system of claim **39**, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

43. The suspension system of claim **37**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

44. The suspension system of claim **37**, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

45. The suspension system of claim **37**, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

46. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a control link floating pivot, a brake link, and a shock absorber; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein said wheel link is connected to said brake link through said wheel link floating pivot; wherein said control link is connected to said brake link through said control link floating pivot; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein force is transmitted to said shock absorber through said brake link; and said suspension system further comprising a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

47. The suspension system of claim **46**, wherein force is transmitted to said shock absorber through said control link, a wheel link fixed pivot, and said control link floating pivot.

48. The suspension system of claim 46, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

49. The suspension system of claim 48, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

50. The suspension system of claim 48, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

51. The suspension system of claim 48, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

52. The suspension system of claim 46, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

53. The suspension system of claim 46, said suspension system further comprising a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; and wherein said rear hub is positioned between components selected from the group consisting of the wheel link, the brake link and a pivot axle, such that said rear hub is removable.

54. The suspension system of claim 46, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

55. The suspension system of claim 46, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

56. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a thru axle; wherein said thru axle is selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; wherein said rear hub is positioned between components selected from the group consisting of the wheel link, the brake link and a pivot axle, such that said rear hub is removable; wherein said wheel link floating pivot is concentric with said wheel rotation axis or within 2 cm thereof; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein said shock absorber is mounted to a link selected from the group consisting of the brake link and the control link, such that said shock absorber is able to respond to movement of a rear wheel; wherein said brake link is pivotally connected to said control link; wherein as the suspension is compressed or extended, said shock absorber is compressed or extended, so that force that compresses or extends said shock absorber is transmitted through said brake link and said wheel link floating pivot; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

57. The suspension system of claim 56, wherein force is transmitted to said shock absorber through said control link and a control link floating pivot.

58. The suspension system of claim 57, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

59. The suspension system of claim 58, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

60. The suspension system of claim 58, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

61. The suspension system of claim 58, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

62. The suspension system of claim 56, said suspension system further comprising a removable pivot axle; wherein said removable pivot axle has a feature for positioning a rear hub in relation to a wheel rotation axis, wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt.

63. The suspension system of claim 56, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub, wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

64. The suspension system of claim 56, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

65. The suspension system of claim 56, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

66. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a removable pivot axle; wherein said wheel link floating pivot is concentric with said wheel rotation axis or within 2 cm thereof; wherein said brake link is pivotally connected to said control link; wherein said removable pivot axle has a feature for positioning a rear hub in relation to said wheel rotation axis; wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein force is transmitted to said shock absorber through said brake link; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

67. The suspension system of claim 66, wherein force is transmitted to said shock absorber through said control link, a wheel link fixed pivot, and a control link floating pivot.

68. The suspension system of claim 66, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

69. The suspension system of claim 68, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

70. The suspension system of claim 68, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

71. The suspension system of claim 68, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

72. The suspension system of claim 66, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

73. The suspension system of claim 66, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

74. The suspension system of claim 66, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

75. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a thru axle; wherein said thru axle is selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; wherein said rear hub is positioned between components selected from the group consisting of the wheel link, the brake link and a pivot axle, such that said rear hub is removable; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein said shock absorber is mounted to a link selected from the group consisting of the brake link and the control link, such that said shock absorber is able to respond to movement of a rear wheel; wherein said brake link is pivotally connected to said control link; wherein said control link fixed pivot is located below a shock pivot, wherein as the suspension is compressed or extended, said shock absorber is compressed or extended, so that force that compresses or extends said shock absorber is transmitted through said brake link and said wheel link floating pivot; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

76. The suspension system of claim 75, wherein force is transmitted to said shock absorber through said control link, a wheel link fixed pivot, and a control link floating pivot.

77. The suspension system of claim 75, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

78. The suspension system of claim 77, said suspension system further comprising a forward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

79. The suspension system of claim 77, said suspension system further comprising a forward moving instant force center that is located behind the wheel link fixed pivot when the suspension is uncompressed.

80. The suspension system of claim 77, said suspension system further comprising a rearward moving instant force center that is located further to the front of the vehicle than the wheel link fixed pivot when the suspension is uncompressed.

81. The suspension system of claim 75, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

82. The suspension system of claim 75, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

83. The suspension system of claim 75, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

84. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, a shock absorber, and a thru axle; wherein said thru axle is selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt, such that a rear hub is mounted concentric to the wheel link floating pivot; wherein said rear hub is positioned between components selected from the group consisting of the wheel link, the brake link and a pivot axle, such that said rear hub is removable; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein movement of said control link about said control link fixed pivot consists of one degree of freedom; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; wherein said shock absorber is mounted to a link selected from the group consisting of the brake link and the control link, such that said shock absorber is able to respond to movement of a rear wheel; wherein said brake link is pivotally connected to said control link; wherein as the suspension is compressed or extended, said shock absorber is compressed or extended, so that force that compresses or extends said shock absorber is transmitted through said brake link and said wheel link floating pivot; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

85. The suspension system of claim 84, wherein force is transmitted to said shock absorber through said control link and a control link floating pivot.

86. The suspension system of claim 84, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

87. The suspension system of claim 84, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

88. The suspension system of claim 84, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

89. The suspension system of claim 84, said suspension system further comprising a removable pivot axle; wherein said removable pivot axle has a feature for positioning said

rear hub in relation to a wheel rotation axis, wherein said removable pivot axle can receive said thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt.

90. The suspension system of claim **84**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub, wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

91. A suspension system for a vehicle comprising a wheel link floating pivot, a wheel rotation axis, a wheel link, a control link, a control link fixed pivot, a brake link, and a shock absorber; wherein said wheel link floating pivot is concentric with said wheel rotation axis; wherein said shock absorber is selected from the group consisting of a damper, a compression gas spring, a leaf spring, a coil spring, and a fluid; and wherein said shock absorber is mounted to a link selected from the group consisting of the brake link and the control link, such that said shock absorber is able to respond to movement of a rear wheel; wherein said brake link is pivotally connected to said control link; wherein movement of said control link about said control link fixed pivot consists of one degree of freedom; wherein as the suspension is compressed or extended, said shock absorber is compressed or extended, so that force that compresses or extends said shock absorber is transmitted through said brake link and said wheel link floating pivot; wherein said suspension system comprises a compressible wheel suspension travel distance that features a beginning travel point where the suspension is completely uncompressed to a point where no further suspension extension can take place, and an end travel point where a suspension is completely compressed to a point where no further suspension compression can take place; and wherein a leverage ratio curve of said suspension system has a negative or a positive slope in the beginning ⅓ (third) and in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

92. The suspension system of claim **91**, wherein force is transmitted to said shock absorber through said control link and a control link floating pivot.

93. The suspension system of claim **91**, said suspension system further comprising an instant force center that is in different locations when the suspension is fully compressed compared to the when the suspension is uncompressed.

94. The suspension system of claim **91**, wherein said leverage ratio curve of said suspension system has a negative slope in the beginning ⅓ (third) and a positive slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

95. The suspension system of claim **91**, wherein said leverage ratio curve of said suspension system has a positive slope in the beginning ⅓ (third) and a negative slope in the end ⅓ (third), and a change in slope value in the middle ⅓ (third).

96. The suspension system of claim **91**, said suspension system further comprising a removable pivot axle; wherein said removable pivot axle has a feature for positioning a rear hub in relation to a said wheel rotation axis, wherein said removable pivot axle can receive a thru axle selected from the group consisting of a solid axle, a thru axle, a hollow axle, a quick release, a skewer, a quick release skewer, and a through bolt.

97. The suspension system of claim **91**, said suspension system further comprising a rear hub, a derailleur hanger, and a brake mount, said derailleur hanger being adjacent to one side of said rear hub, and said brake mount and brake link being positioned adjacent to the opposite side of said rear hub; wherein said wheel link is mounted outboard of and adjacent to said brake mount and said brake link.

* * * * *

CERTIFICATE OF SERVICE

I, Robyn Cocho., being duly sworn according to law and being over the age of 18, upon my oath depose and say that:

Counsel Press was retained by ALAN ANDERSON LAW FIRM LLC, Attorneys for Appellant to print this document. I am an employee of Counsel Press.

On **April 22, 2014** counsel for Appellant has authorized me to electronically file the foregoing **Brief for Plaintiff-Appellant (confidential and non-confidential copies)** with the Clerk of Court using the CM/ECF System, which will serve via e-mail notice of such filing to all counsel registered as CM/ECF users, including any of the following:

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Copies will be emailed to the above counsel on this date and 2 paper confidential copies will also be mailed to the above principal counsel on this date.

Upon acceptance by the Court of the e-filed document, six paper confidential copies will be filed with the Court, via Federal Express, within the time provided in the Court's rules.

April 22, 2014.

/s/ Robyn Cocho
Counsel Press

CERTIFICATE OF COMPLIANCE

I certify that the foregoing Brief for Plaintiff-Appellant Split Pivot, Inc. complies with the type-volume limitation of Federal Rule of Appellate Procedure 32(a) and contains 13,939 words, excluding parts of the brief exempted by Federal Rule of Appellate Procedure 32(a)(7)(B)(iii) and Federal Circuit Rule 32(b).

I further certify that this brief complies with the typeface requirements of Federal Rule of Appellate Procedure 32(a)(5) and the type style requirements of Federal Rule of Appellate Procedure 32(a)(6). This brief has been prepared in a proportionally spaced typeface using Microsoft Word in 14 point Times New Roman font.

Dated: April 22, 2014.

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